OPERATIONS GUIDE

INFRARED FIRE MAPPING UNIT

U. S. DEPARTMENT OF AGRICULTURE /FOREST SERVICE/ WASHINGTON, D. C.

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OPERATIONS GUIDE

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I. INTRODUCTION

This guide contains background and basic information for fire control organizations using or planning to use infrared techniques for fire mapping. It may also serve as a reference for a mapping crew.

Infrared fire mapping in the U. S. Forest Service became operational in July, 1966. Almost five years of research and development has produced an instrument which supplies photo-like imagery of heated fire areas, together with surrounding terrain details. Mapping is done from an aircraft flying over the fire and the adjacent terrain. Imagery may be produced night or day. Timely, accurate intelligence can be furnished to the fire manager during periods of smoke obscurity and darkness. Infrared mapping is a major new reconnaissance tool and fire management aid.

Personnel requirements and operational procedures are based on experience gained from mapping 68 large rural fires and from an exercise conducted in cooperation with the City of Los Angeles and its mutual aid partners. The Los Angeles exercise tested the equipment and crew's capability to gather urban intelligence on a nuclear attack scale. Techniques were developed to help urban fire managers use the equipment and its output effectively.

Results of these operations indicate the prototype model capable of both peacetime and wartime fire mapping and of providing fire

intelligence at rates and under conditions impossible with conventional methods.

II. SYSTEM COSTS AND REQUIREMENTS

A specially equipped multi-engined aircraft of the Twin Beach or Aero Commander Class is required to carry the equipment and crew. Depending on the optional equipment installed, costs for the airplane exceed $100,000.

The infrared equipment presently available to the fire services is a prototype model and investment costs are high. Costs for production models are unknown but are estimated to be in the $100,000 to $150,000 range.

Annual operating costs are estimated at $150,000. This includes salaries for three men; aircraft operation, maintenance, and hangar space; mapping equipment operation, supplies, operations support, storage, and office.

Charges for use on project fires are about $500 per day. This includes aircraft time, overtime for 3-man crew, per diem, and photographic supplies.

In addition to the hardware, certain other key elements are vital to a successful infrared fire mapping operation. These are as follows:

1. A trained interpreter is essential for fire managers to get maximum benefit from the imagery.
2. A trained and experienced electronics technician is essential to operate the equipment; and to provide emergency maintenance.
3. A pilot with skill in precision flying is required for infrared mapping.
4. Organization support is necessary to provide supervision, coordination of requests and priorities.
5. An operating base must be designated for each mission.
6. A home-base operating facility is required. It must afford access to the following:

    aircraft storage and maintenance
    electronics maintenance
    optics maintenance
    photographic laboratory
    office space
    ready room for crew
    organization support and direction,
       including clerical services

III. PERSONNEL

A. QUALIFICATIONS

Primarily because of the technical skills involved, year-long permanent personnel are necessary. A brief description of backgrounds essential for these positions is presented.

Crew members must be willing to fly in many types of aircraft. They may be required to work long, irregular hours, under adverse conditions, and may remain away from their home base for extended periods.

1. Coordinator-Interpreter

   The Coordinator-Interpreter must be knowledgeable in fire strategy and tactics pertinent to the assigned mission, urban or rural. He should have broad experience in fire control work.

   A fully-qualified wildland fire Coordinator-Interpreter can readily adapt to urban fire conditions provided he has the assistance of an able urban fire officer. An understanding of structural fire department procedures, communications and terminology is essential to provide the necessary link between these related fields.

   Additional Desirable Qualifications:

   a. Ability to communicate well, in order to train others to interpret infrared imagery.

   b. Field experience and/or a formal course in aerial photo interpretation.

c. Completion of an advanced fire behavior course, plus fireline experience.

2. Interpreters (Can be assigned from other positions on a short-term detail basis)

During overload situations, special extra interpreters are required; normally one for each major fire area. These positions are filled with men who have been trained at a two-day special session or while on large fires. They are usually technicians who have had field experience and training in aerial photo interpretation. Wide experience on fires is essential.

Ordinarily top fire overhead are not trained for this job, since their post requires full time coverage during most fire operations. Usually the interpreter's position is set up in the plans section where the incumbent functions as a scouting or mapping specialist.

3. Pilot

The pilot must meet fire agency qualifications as to experience and type rating. He must have had experience flying in support of wildfire suppression operations. He should be thoroughly checked out and trained in flight techniques common to infrared flying, including imagery dropping procedures. This includes precise navigation

under conditions of low visibility, without the usual aids. It requires low level flight, many times in mountainous terrain.

Additional Desirable Qualifications:

a. Wide experience in instrument flight. Flights are often in adverse weather and at night, over uncharted courses, frequently without ground navigation aids.

b. Aircraft maintenance experience.

c. Ability to communicate well, in order to interrogate available pilots concerning their observations and experiences, primarily over going wildfires.

d. Ability to instruct and advise others both on the ground and while airborne, regarding safety precautions, methods, controls and accuracy in dropping smokejumpers, cargo and chemicals.

4. Electronics Technician - Operator

This position must be filled by a skilled technician with an extensive electronics background, and the ability to trouble-shoot and repair new types of equipment. He should be imaginative enough to recommend improvements in equipment, as well as repair it immediately. It will be necessary for him to learn imagery interpretation well enough to recognize if it is of the quality required for fire intelligence.

Additional Desirable Qualifications:

a. An aptitude for photography and optics because of their integration in the equipment.

b. A knowledge of wildfire control techniques.

c. Thorough familiarity with the fire agency radio equipment and operational procedures.

B. TRAINING

Men selected to serve with an Infrared Fire Mapping Unit need not possess all needed knowledge and skills at the start. With the stated qualifications, plus ability and willingness to learn, they can be trained for large fire operations.

For the three full-time members of the unit, on-the-job training will usually be feasible, provided an overlap is allowed with an operating unit.

For interpreters assigned on a short term, or project fire basis, group classroom instruction is effective. A pool of qualified interpreters has been built up in western states within U.S. Forest Service, Bureau of Land Management, Park Service, Bureau of Indian Affairs, and state, city, and county fire agencies. Appendix "J" contains detailed guides for training crew members.

IV. EQUIPMENT AND FACILITIES

A. AIRCRAFT

1. Types

a. Development indicates that the desirable aircraft is a light twin-engine aircraft, with good takeoff and flight performance. It should meet the following general requirements:

> Excellent in-flight ground visibility.
> Useful load capacity minimum of 3200 lbs.
> Cabin space at least 250 cubic feet, plus baggage space of 50 cubic feet.

Examples of aircraft which meet these minimums are the Grand Commander and the Beechcraft Queen Air.

b. The aircraft used has been the Aero-Commander, Model 500-B. It has performed adequately, but barely accommodates the prototype infrared scanning equipment and 3-man crew. It cannot handle supplies and baggage for a 2-day mission. This requires one man to travel by other means. It cannot accommodate additional, though temporary, equipment to allow testing of new techniques. It cannot be used for training unless some equipment is unloaded. The speed and performance of this aircraft is adequate.

2. Modifications

The following modifications were necessary in the Aero-Commander Model 500-B.

a. Two 90 ampere heavy duty generators on each engine.

b. One 75 ampere heavy duty battery.

c. Three cannon plug outlets, each with a separate 25 ampere circuit breaker.

d. Original seats removed except pilot, co-pilot and a single seat for operator (placed next to exit door).

e. A portable stand installed forward of operator to accommodate necessary scanner equipment.

f. Scanning view hole constructed in the bottom of aircraft, permitting 120° unobstructed view.

g. Quick-release door exit.

h. Launching chute for dropping capsules with imagery.

3. Recommended Future Installations in Infrared Mapping Aircraft

a. A Bendix type M-G-54, 250 V-A, 115V, 400 CPS, three phase rotary inverter, with circuitry protection, control relay switches, and monitoring meters. An inverter power relay (AN-3350-2) with minimum AC output of 115V, 400 CPS, three phase, 1.25 ampheres

per phase, 40% efficient, 150% load current - 5 minutes with a d.c. input voltage range of 26 to 29 and ampere range of 24.1 to 21.6. (This installation will eliminate the high voltage power supply and related problems).

b. A radar altimeter.

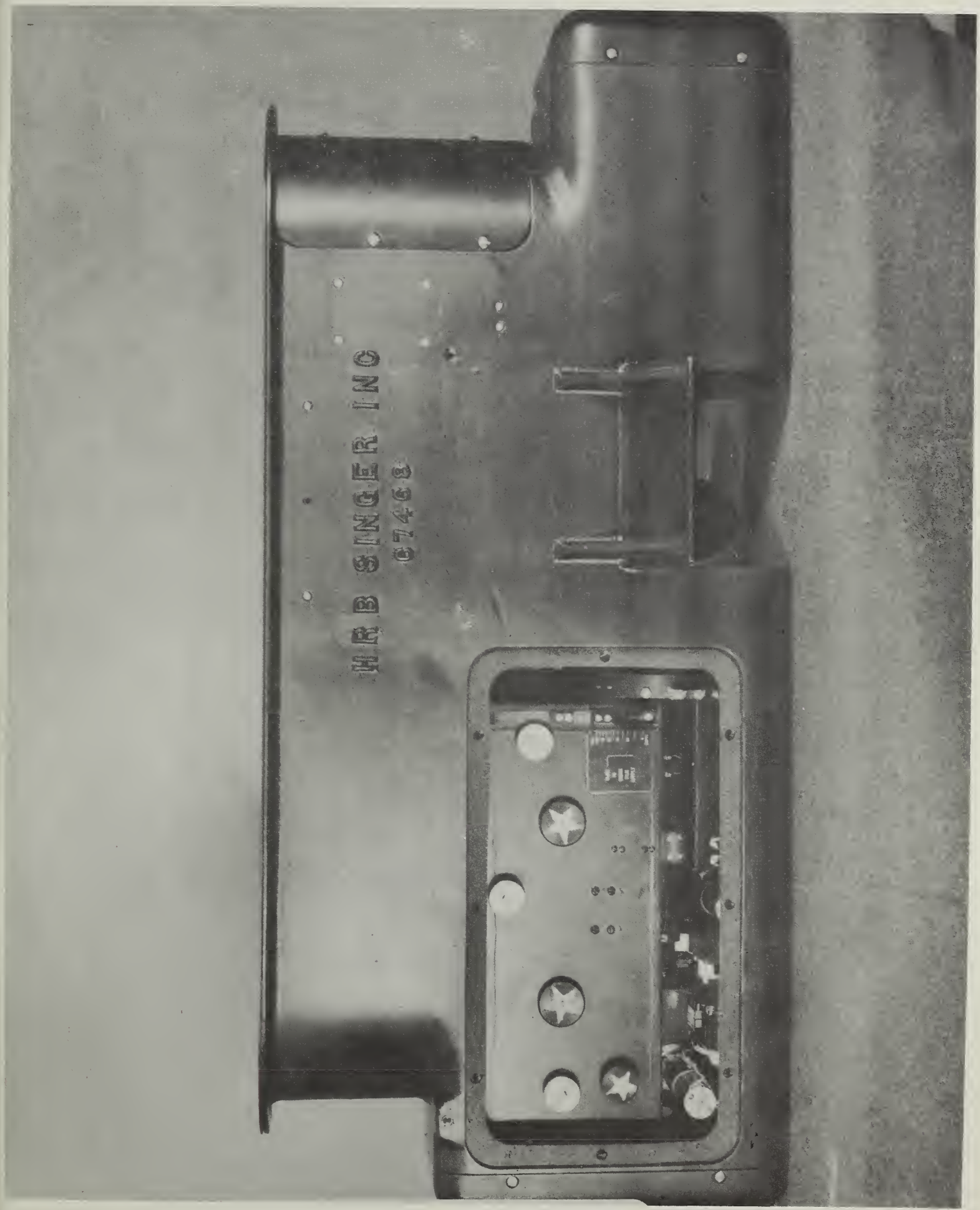
4. Drawings

Construction details and material specifications are not included in this guide. Drawings and specifications accompanying supplemental type certificate #SA1106 WE are available from the Forest Service, Western Zone Air Unit, 3104 Airport Way, Boise, Idaho.

B. AIRBORNE INFRARED EQUIPMENT

1. The Scanner

This unit (Fig. 1) is designated as Reconofax XI. Built by HRB Singer Co., it is an airborne line-scan thermal imagery device. Its product is an image of the terrain flown over. The scanner contains a rotating optics system, which scans an arc under the aircraft, and focuses the radiated thermal energy on an infrared detector. This signal is amplified and reproduced upon a moving film, and/or upon a Polaroid film.



(Fig. 1) Scanner Reconofax XI

The resulting imagery has the characteristics of a photograph, which is produced one thin line at a time, with shades varying from black to white proportional to the temperature of source objects.

a. Functions

(1) Receives infrared radiation from the ground by means of an optical-mechanical scanner.

(2) Converts the infrared variations into video signals.

(3) Continuously records these video variations on Polaroid film and/or 70 mm strip film in the scanner, producing photograph-like imagery.

(4) Gyroscope control compensates for aircraft roll up to 10°.

b. Characteristics

(1) Scan angle: normal 120°; also 60° may be used for Polaroid.

(2) Weight: 90 lbs., dimensions: 33" x 14" x 6 1/2"

(3) Operates on aircraft power, 28 volts d.c.

(4) Detector - Indium antimonide cooled with liquid nitrogen (321° F below zero)

(5) Mounted in the floor of aircraft opening permits it to scan the ground.

2. The Control Assembly

a. Functions

This unit (Fig. 2) contains all the controls for adjusting the scanner.

b. Characteristics

(1) Weight: 20 lbs.; dimensions: 12" x 11" x 9"

(2) Mounted on stand in aircraft for operator's convenience.

3. Printer Scope

This unit (Fig. 3) contains the electronic assembly which provides the cathode ray tube signals from the scanner to be reproduced as a visual line for photographing.

a. Functions

(1) Controls the signals to produce the imagery on Polaroid film.

b. Characteristics

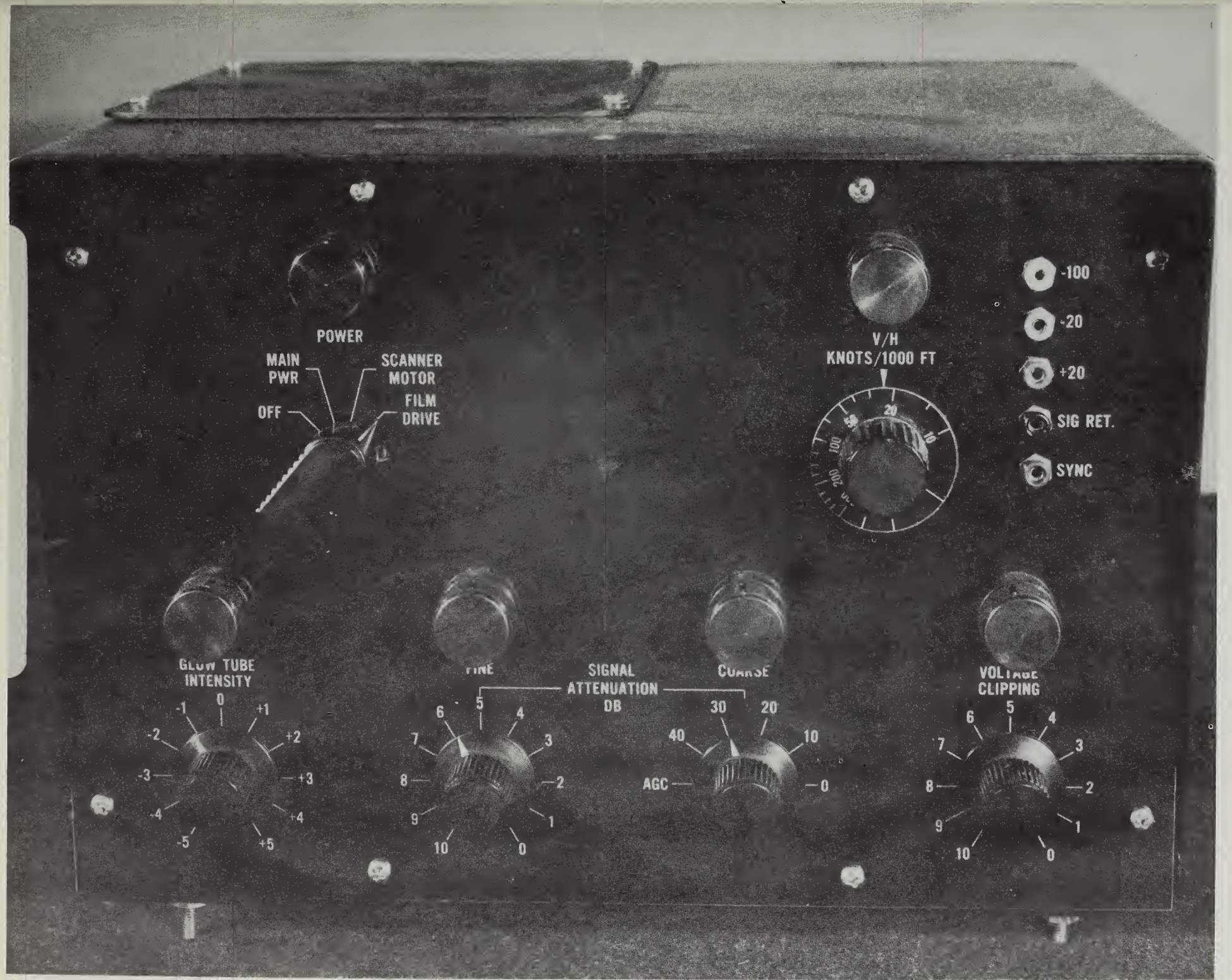
(1) Scan angle: 120° or 60° (selectable).

(2) Weight: 28 lbs; dimensions: 22" x 11" x 7".

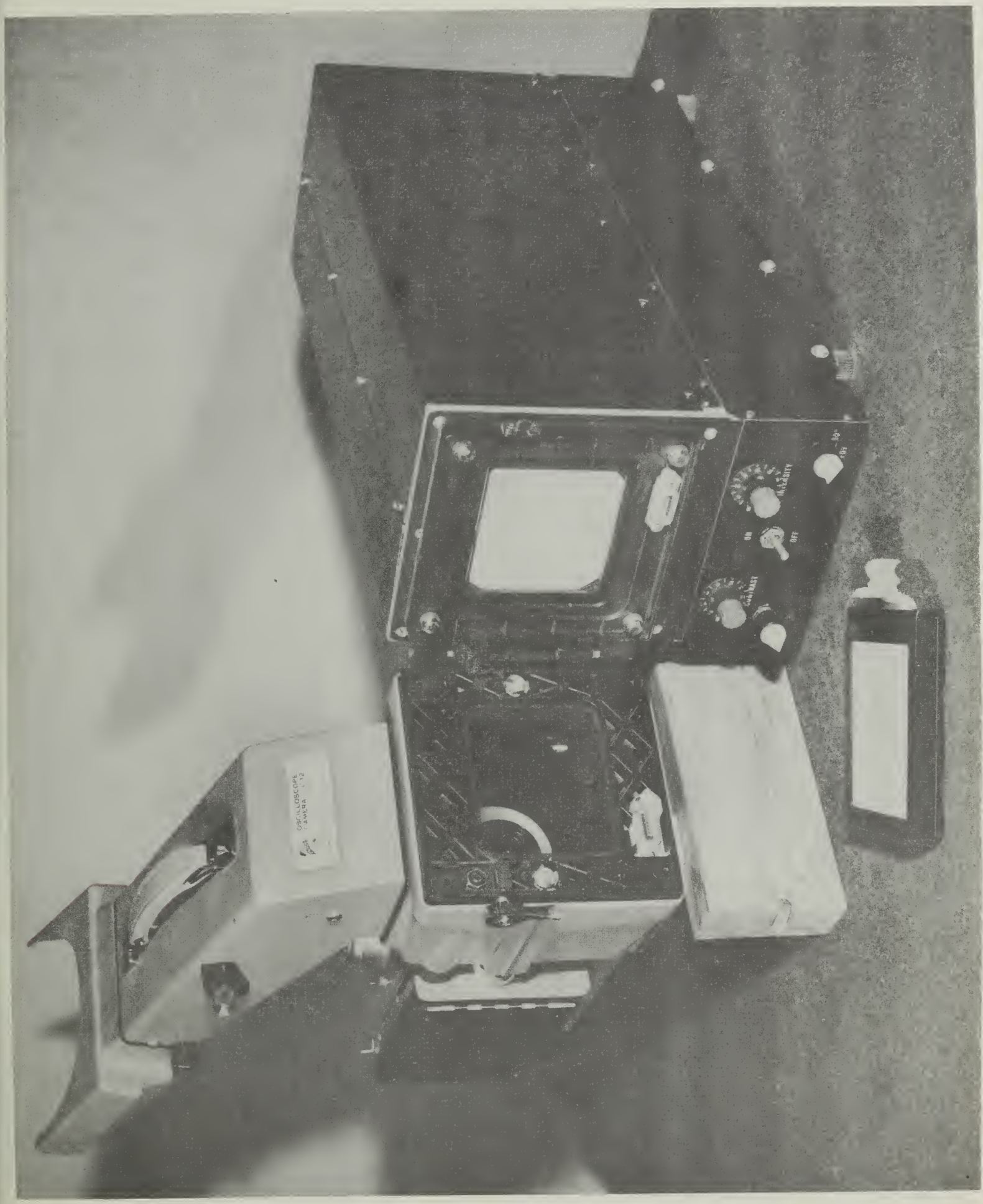
(3) Mounted on operator stand next to control box.

4. Polaroid Attachment

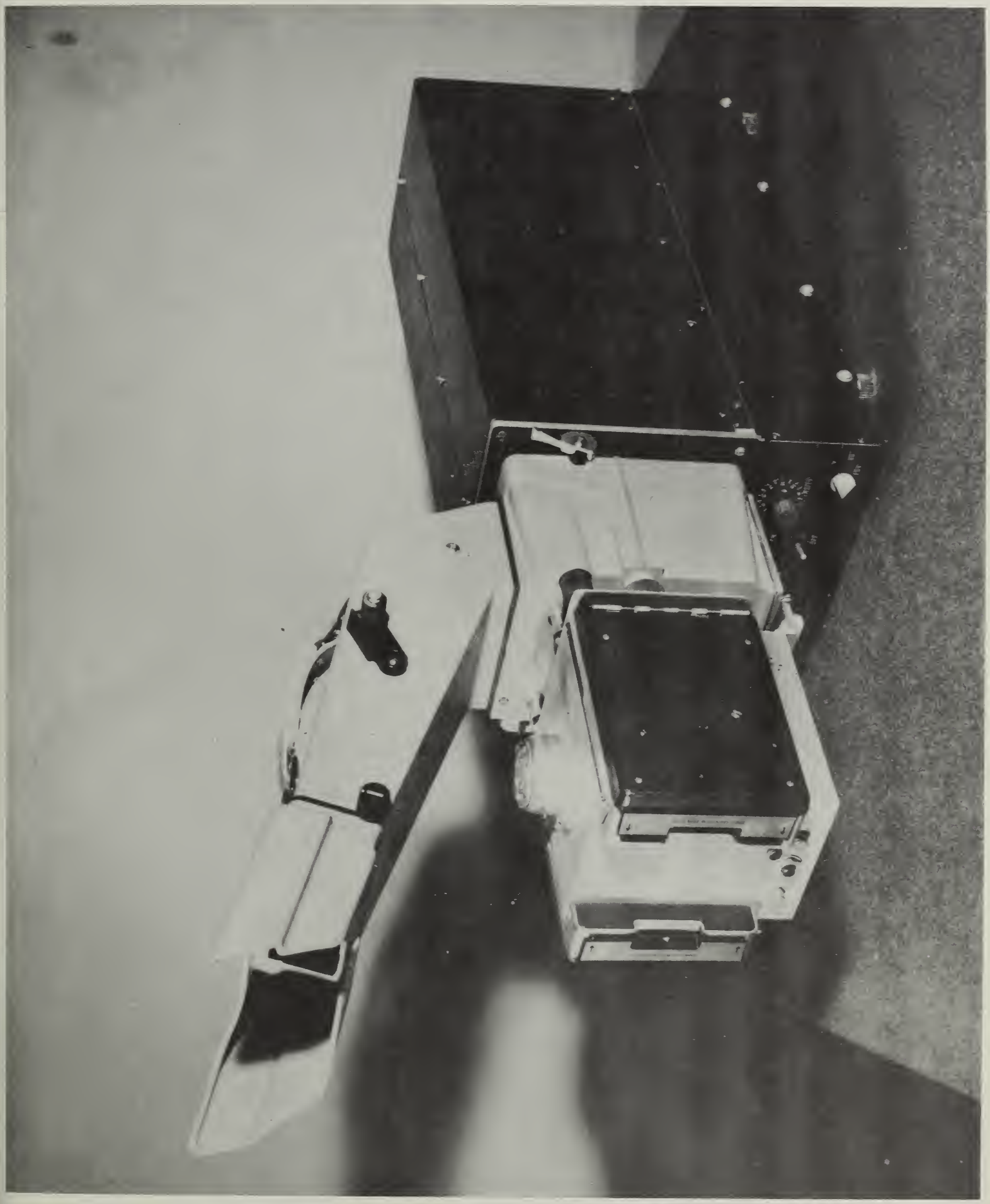
This assembly (Fig. 4) contains a C12 camera lens, a flipping mirror arrangement, slate windows, clock, two Polaroid film packet backs, controls, and electronics which allow compatible operation with the printer scope.



(Fig. 2) Control Assembly



(Fig. 3) Printer Scope



(Fig. 4) Polaroid Attachment -
Printer Scope Closed

a. Function

(1) Obtains critical imagery within 10 seconds after the presentation.

b. Characteristics

(1) Weight: 15 lbs.; dimensions: 12" x 14" x 7".

(2) A viewing door permits visual inspection of the printer scope line presentation.

(3) It is mounted on the front of the printer scope.

5. Monitor Scope

This is a 2 channel portable d.c. powered oscilloscope, (Fig. 5) permitting visual observation of signals being applied from the control assembly.

a. Function

(1) It permits the operator to properly adjust signals on one channel and presents a visual signal at the same time on the other channel.

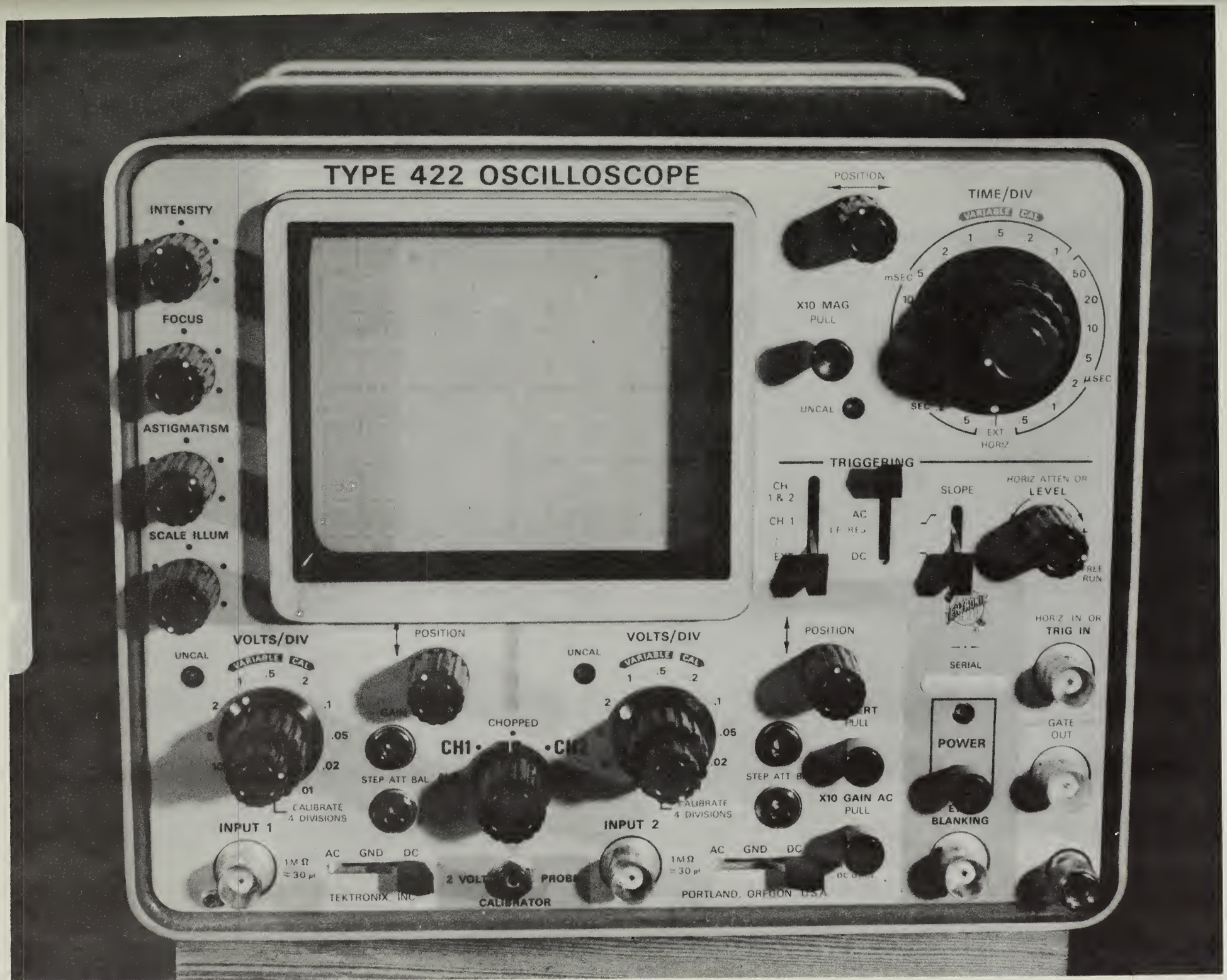
b. Characteristics

(1) Weight: 201 lbs.; 17" x 9" x 7".

(2) Mounted on stand with control assembly and printer scope.

6. Dropping Assembly

This assembly (Fig. 6) is a combination of an ejector tube and drop capsule. It allows control by the pilot so imagery may be dropped accurately and without danger to the aircraft.



(Fig. 5) Monitor Scope

(Fig. 6) Dropping Assembly

a. Function

(1) This assembly allows the pilot to control ejection of a drop capsule containing imagery.

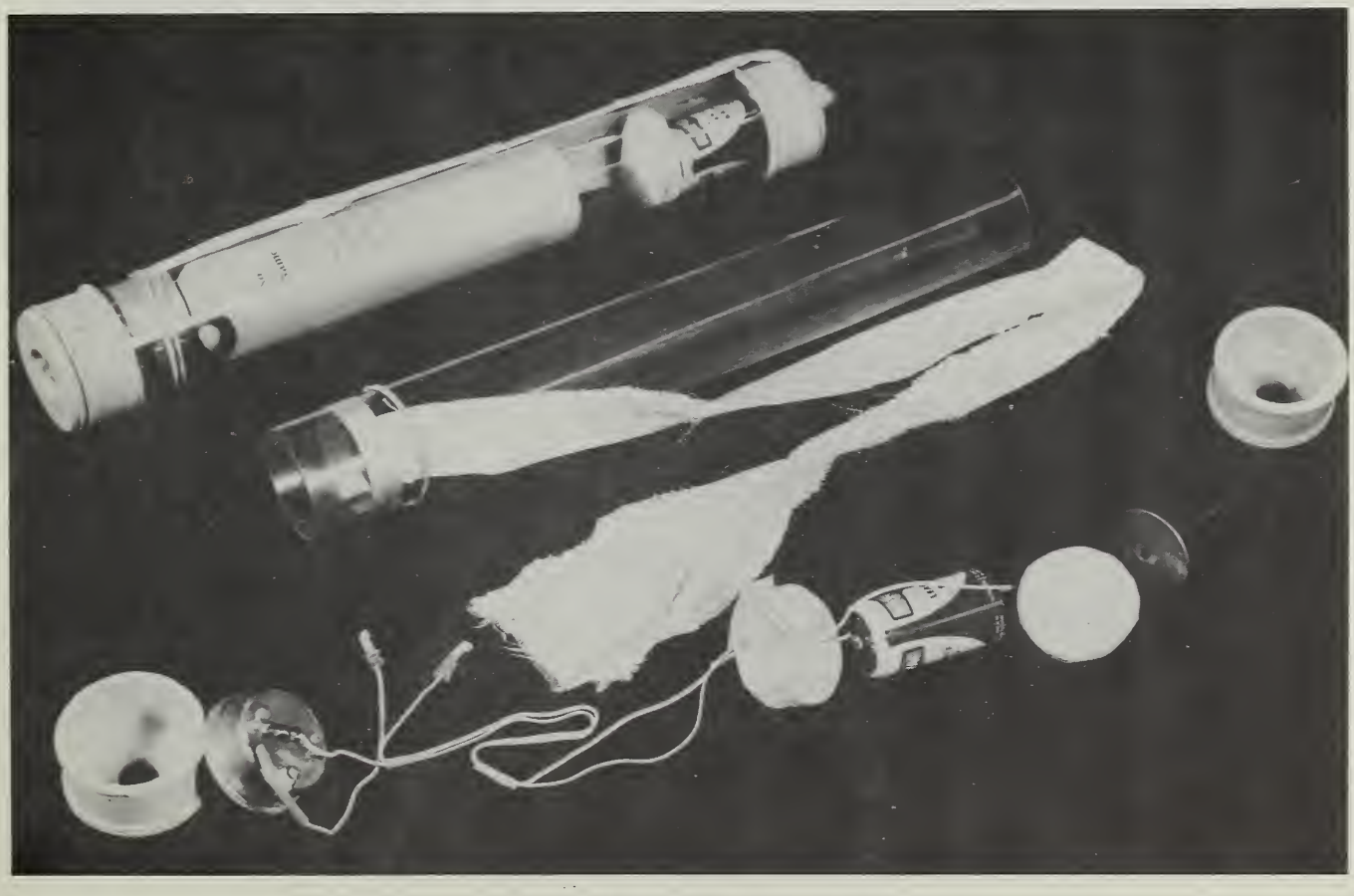
b. Characteristics

(1) An ejector tube is mounted through a hydraulically controlled trap door. An electro-magnetically controlled gate releases the drop capsule. It is controlled by the pilot.

(2) The drop capsule components (Fig. 7) are in a plastic tube with a battery-powered attention device. A horn is used during daylight hours; a flashing light and horn are used at night.

(3) The capsule is prepared for dropping by the operator, and is dropped free-fall at a target.

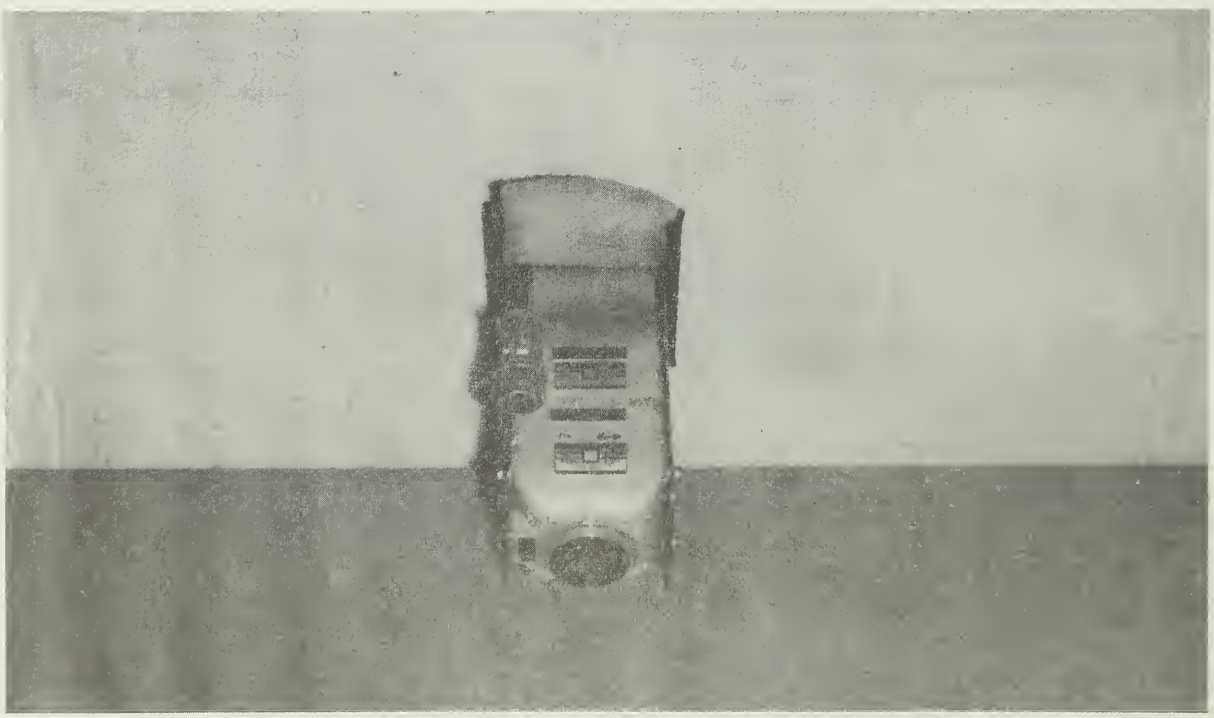
Note: The capsule weighs 1½ lbs; and, in free-fall, presents a risk to personnel. Target areas must be carefully selected.



(Fig. 7) Drop Capsule Components with Daytime Signal

7. 70 mm P-2 Aerial Camera

This unit (Fig. 8) takes conventional daylight aerial photographs of the same area represented by infrared imagery, for comparison purposes. It mounts in the same location as the dropping assembly. Control is handled independently of other components. Use of this unit may be discontinued without major loss in capability.



(Fig. 8) 70 mm P-2 Aerial Camera

8. Liquid Nitrogen Dewar

This container (Fig. 9) provides storage for the liquid nitrogen which is required for cooling the detector. The dewar has a 25 liter capacity (26.25 quarts). It is normally carried in the baggage compartment of the aircraft. A one quart thermos bottle supply is carried in the cabin of the aircraft on each sortie.

(Fig. 9) Liquid Nitrogen Dewar

C. BASE FACILITIES

1. Electronic Equipment

The following electronic equipment is necessary for maintenance of the Infrared Mapping Unit.

a. Vacuum tube volt meter - Hewlett Packard Model 410-B or equal.

b. Audio signal generator - Hewlett Packard Model 210-A or equal.

c. Squarewave Signal Generator - Hewlett-Packard Model 210-A or equal.

d. Power supply - Motorola Model T-1012-A or equal.

e. High Voltage Probe for Hewlett-Packard V.T.V.M. Model 410- Probe Model 459-A (d.c. resistive voltage multiplier) or equal.

f. Oscilloscope - Dual Trace - Tektronix Model 422 or equal. (This oscilloscope is the monitor scope used with the Infrared Mapping Unit). It can be used as a test unit.

g. Oscilloscope, Tektronix Model 564, with plug-ins 3A6 and 3B3, mounted on tektronix. Scope-Mobile Model 201-2, with drawer and plug-in housing, Model D.

Note: A complete set of bench tools is necessary. It should consist of the usual tools used by electronics technicians. A catalogue case should be included for carrying manuals and spare parts.

2. Operations Support

a. Office facilities should include desks, tables, bookcases, files, access to duplicating equipment, and to photographic laboratory facilities. It will be shared by three permanent crew members.

b. Aircraft facilities should include the following: Locked hangar storage, with access at all hours, and aircraft maintenance, either contract or other.

c. Electronics shop facilities with shop bench space, bookcase and record file cabinets, test equipments, and fireproof storage for parts and supplies.

d. Personnel needed in addition to the 3-man team include clerical services, and occasional part-time electronic technician services.

D. INFRARED EQUIPMENT INSTALLATION

Detailed instructions on installation of equipment in the aircraft are contained in Appendix A. Because this equipment is so sensitive to adjustment changes, the utmost care must be exercised to avoid shocks through jarring or dropping the units.

V. OPERATIONAL USES

A. PROCEDURE

The following procedure is used by the U.S. Forest Service. It illustrates one way use arrangements can be set up.

1. Request for Unit

   a. All requests by Forest Service Regions are made to the Regional Coordinator.

   b. All requests by other Fire Agencies are through their respective Forest Service Regional Headquarters, and to the Regional Coordinator.

   c. A direct contact usually is made by the Coordinator-Interpreter to obtain necessary data.

2. Time Factors

   a. Departure Times

      1. One hour or less departure time is required, when crew is on standby at base.

      2. One to three hours departure time when crew is at home, at night, or on days off.

   b. Travel to Fire

      1. Arrival time at fire will depend on distance from base.

c. On-Fire Operations

On arrival, the first imagery may be taken with the full crew aboard the aircraft. A landing is then made, and the Coordinator-Interpreter accompanies the imagery by car or helicopter to the fire headquarters. He assists with imagery interpretation, and selects a drop spot if additional imagery is to be air dropped. Subsequent sorties are accomplished with only the pilot and technician operator aboard. Drops are made as necessary.

B. CAPABILITIES

1. Fires can be mapped either day or night. Night imagery is usually the best; daytime quality varies, depending on the temperatures encountered. Imagery can be taken at sunrise or sunset but the quality may vary widely.
2. Imagery of fire perimeter or spot fires is not attenuated by dense smoke from forest fuels.
3. Rapid surveillance can be made during critical periods.
4. When imagery is of good quality, accurate plotting of fire perimeter and spot fires is possible.
5. Accurage rates-of-spread can be calculated by flying a series of sorties at intervals.

6. Infrared imagery provides the fire boss with up-to-date changes in the landscape; such as new logging units, urban renewal projects, and recently constructed roads or improvements.

7. If a safe location for dropping can be selected by the pilot, imagery may be dropped directly to a fire headquarters day or night. A plastic drop capsule weighing 1 1/2 pounds is used to free-fall the prints. If smoke and terrain at the headquarters preclude dropping, imagery must be delivered by other means.

8. Imagery provides excellent information on remaining hot spots when fire is in mop-up stage.

C. LIMITATIONS

1. Quality is not uniformly good. If imagery is poor quality, the fire perimeter is sometimes difficult to determine accurately. Up-to-date aerial photos, or a combination of contour maps and some knowledge of the fire perimeter, helps speed up interpretation.

2. Infrared energy does not penetrate solid matter. Tree foliage or buildings may cause gaps to appear in mapped perimeter or obscure small spot fires. Fog and clouds between the scanner and ground cannot be penetrated.

3. Air turbulence associated with strong convection columns can delay the scanning of portions of the fire perimeter.

4. A minimum two days training is needed to acquire skills necessary to interpret infrared imagery and translate maps or aerial photos.

5. The equipment presently in use is a prototype and not completely dependable. If a breakdown occurs on a fire, the repair of the equipment at the scene may not be possible. Some components are not available in less than 90 days. On-shelf storage of these units is expensive, but may be necessary to assure nearly continuous operation.

6. A hard surface runway equipped with lights is required for night landings and take-offs.

D. IMPACT ON USING UNIT

1. A three-man crew is dispatched: the pilot, equipment operator, and coordinator-interpreter.

2. All necessary equipment arrives with the Unit. Some items may need replacing, such as: Polaroid film, liquid nitrogen, and drop capsules.

3. When requests for sorties exceed the 6 hour per day pilot limitation or after several days of broken shift work, a relief pilot is needed.

4. The coordinator needs transportation from the airport base of operation to the fire camp.

5. Transportation must be available for the aircraft crew twenty-four hours a day, to meet the schedules requested by the Fire Boss.

6. Local infrared interpreters should arrive at the fire as soon as possible.

7. Up-to-date aerial photos and good maps should be available. Overlay material, such as acetate, works well on aerial photos and imagery.

E. PRODUCT

1. Polaroid imagery, size 3 1/4" X 4 1/2", is produced. It can be spliced together in the line of flight to form a continuous picture.

2. Imagery can be spliced together from each overlapping flight line, but it may be slightly distorted due to variation in speed and height of the aircraft and terrain elevation changes.

3. Accuracy depends on the quality of imagery obtained. This varies with many factors. The most important is the temperature differential encountered.

4. Intelligence on the fire is provided at intervals required by the Fire Boss, if possible.

5. Acreage and perimeter figures for planning and for progress reports are produced with considerable improvement over methods ordinarily used.

6. Up-to-date information is provided for release to the news media. This will include size, movement, intensity, property threatened, and other information normally difficult to provide.

VI. ON-SITE PROJECT FIRE OPERATIONS

A. SCHEDULING MAPPING FLIGHTS

In U.S.F.S. field use, the Fire Boss or Plans Chief requests imagery be made at a specific time to serve operational and planning needs. Discussion with the coordinator is desirable so constraining factors such as time of day, fog, or pilot hours may be considered.

Each flight should have specific mapping objectives such as: entire perimeter, specific sectors, or low elevation for details.

B. DELIVERY

1. After imagery has been obtained, communications contact by radio must be made between aircraft, air officer and coordinator on the ground to assure a safe drop.
2. During daylight hours a safe drop zone area is located by the coordinator and/or local regional interpreter. It is well marked.
3. During darkness the same drop area is used. Two strobe lights (2 million lumin power) are set out 30 feet apart near the target as signals for the pilot.
4. If imagery cannot be dropped safely, the aircraft returns to base, and imagery is delivered by other means.

VII. APPENDIX

APPENDIX A

INSTALLING INFRARED EQUIPMENT IN AIRCRAFT

Note: Extreme care is essential in handling infrared units. See Exhibit A-1 for diagram of mounting locations.

A. SCANNER

1. Before entering aircraft, align scanner fore and aft with aircraft, orient front of scanner, (the end opposite the detector-dewar assembly) toward front of aircraft, and place scanner carefully on operations seat.

2. Enter aircraft, and with a firm position, carefully place scanner in well.

3. Place mounting brackets on scanner with four cap screws. (Do not over-tighten screws.) Bottom of brackets should be on floor of aircraft. If not, lift scanner and shift it until brackets are on floor.

4. Secure fasteners, one-quarter turn, on each bracket.

B. CONTROL BOX

Place control box on left side of equipment table, aligning studs with four holes provided. Tighten the four hexagon nuts which hold it in place.

C. PRINTER

1. Remove camera assembly by releasing lock and lifting.

2. Place printer on right side of equipment table, and align the four holes.

3. Secure printer with cap screws and lock washers.

FIRE MAPPING SYSTEM INSTALLATION FOR AERO – COMMANDER

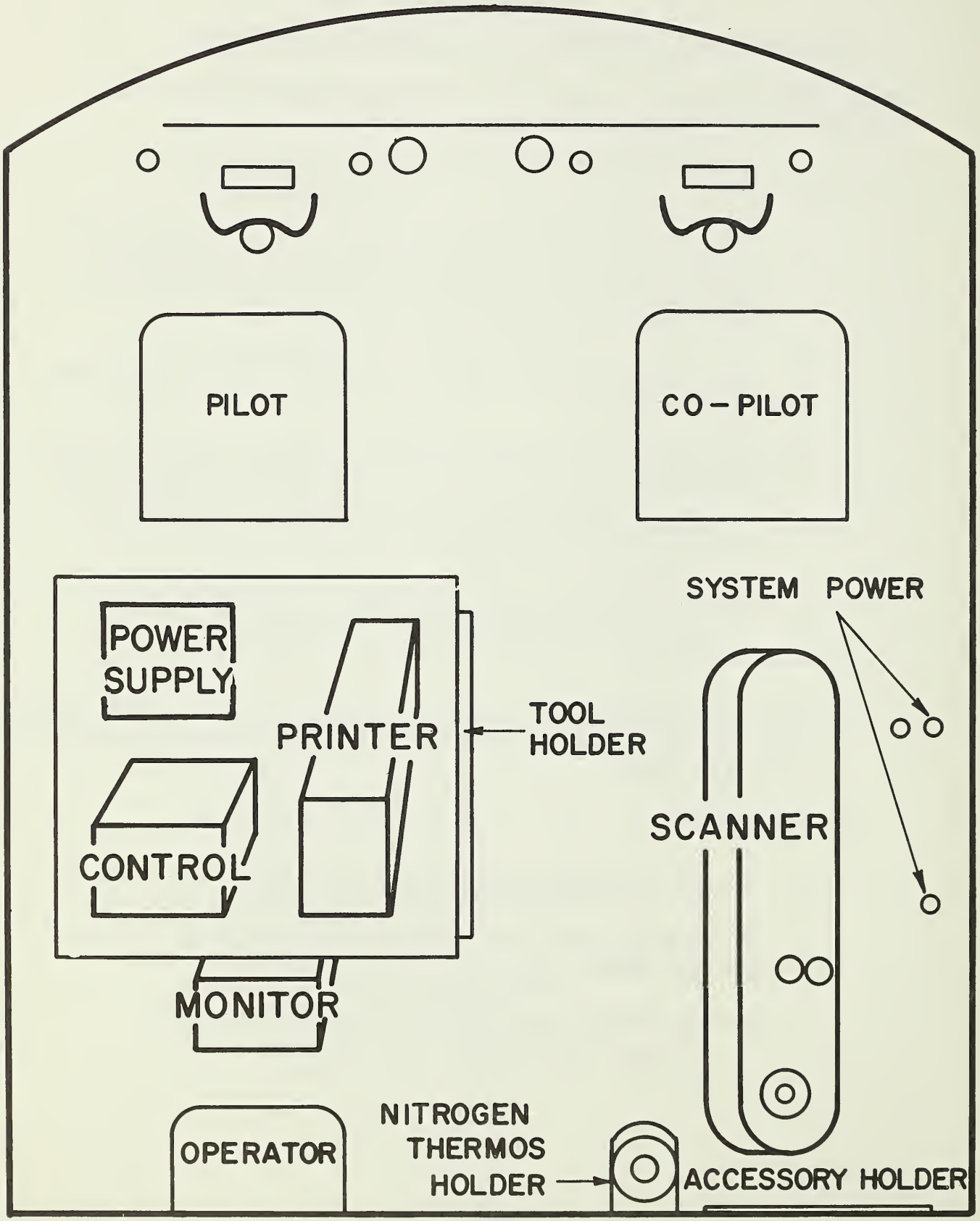


EXHIBIT A-1

D. MONITOR SCOPE

1. Be sure POWER MODE switch on the rear of the monitor is in the 11.5-35 v.d.c. position.

2. Connect the connector-protector (on the chain) to CATHODE connector on rear of monitor.

3. The monitor slides into frame below equipment table.

E. DUAL POLAROID CAMERA

1. Carefully align the two guide pins on left side of camera with printer front plate.

2. Carefully close camera, being sure electrical connection near bottom right of cathode ray tube is in correct alignment.

3. Secure camera to printer by pushing locking arm on right side of camera upward, clockwise (CW).

F. SECURING EQUIPMENT AFTER USE

Always lock aircraft when personnel will not be present.

APPENDIX B

PREFLIGHT PROCEDURES

The following preflight steps are necessary to complete preparation for a sortie.

A. USE PRE-SORTIE CHECK LIST

Note: Remove scanner port cover during pilots preflight

B. LOAD 70 MM MAGAZINE FILM CASSETTE

1. Cassette Removal

The cassette is removed from the scanner in the following manner:

a. Remove the film recorder access panel located on the side of the scanner (Exhibit B-1).

b. Pull out on the spline and slip the spline spacer into position to keep the spline in a disengaged position.

c. Loosen the three film cassette fastener screws.

d. Lift up and pull the cassette away from the scanner through the access opening.

2. Cassette Loading

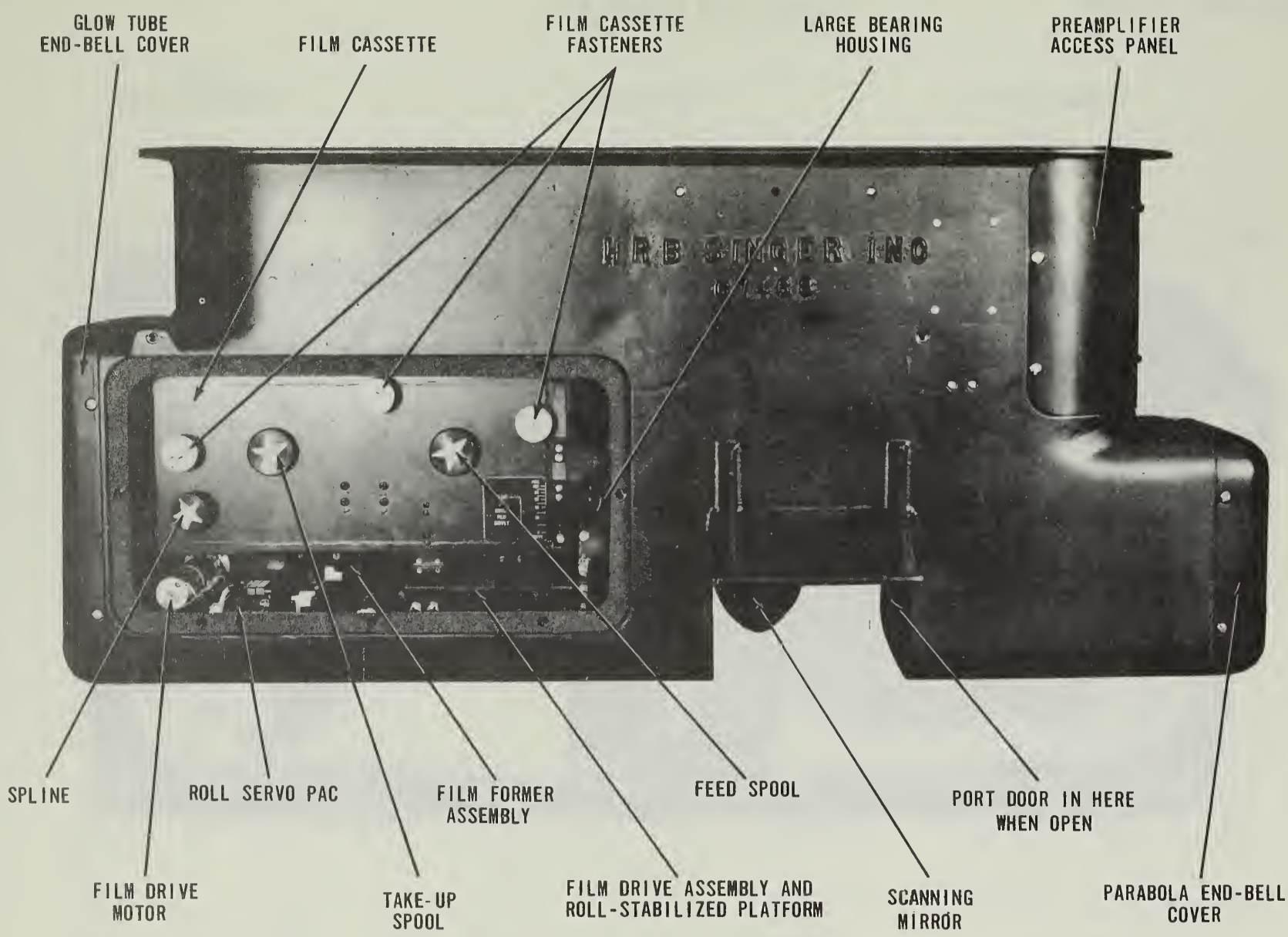
The cassette is loaded with film in the following manner (Exhibit B-2):

a. Place magazine on flat surface with film former away from installer and all knobs down.

b. Remove cover by loosening the four screws in the corners of the cover. These screws may be loosened in daylight and removed in the dark.

c. Place a roll of film on the supply spindle which is on the installer's right side.

d. Feed the film around the idler roller so that the emulsion side is on the outside of the roller.



SIDE VIEW OF RECONOFAX XI SCANNER

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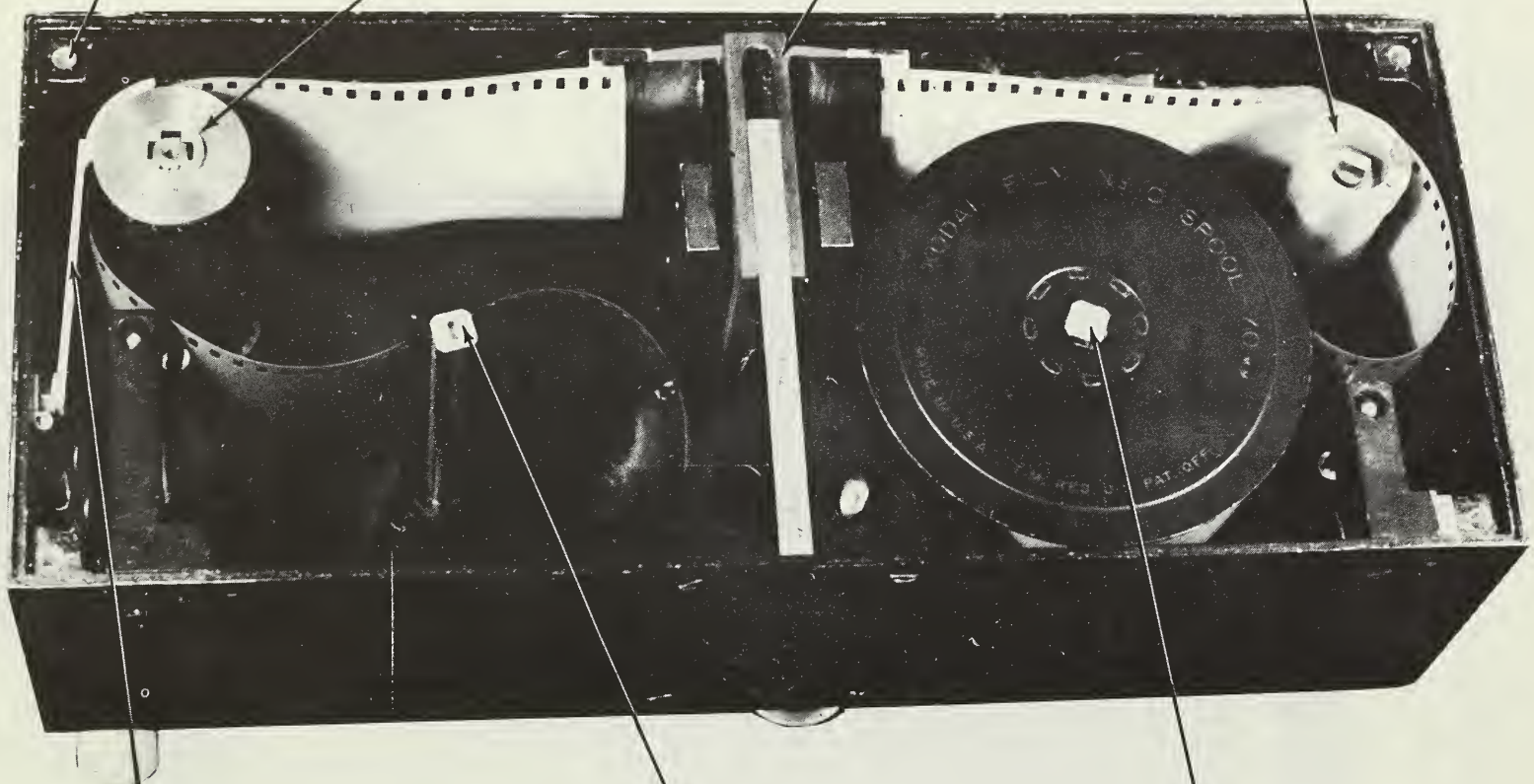
EXHIBIT B-1

EXHIBIT B-2



FILM CASSETTE WITH COVER OFF

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e. Thread the film through the film forming plate. This step may be accomplished easier if the end of the film is cut at an angle. An alternate method is to feed film past the forming plate and then slip the edge through the side of the plate and into position.

f. Feed the film between the take-up sprocket and the sprocket pressure plate until perforated edges of the film are engaged in the sprockets. Feed enough film through the sprocket to reach the take-up spool and then several inches more.

g. Insert film into slot on the take-up spool and secure film to spool with a short strip of masking tape. Lower the spool onto its spindle. Feed about one turn of the film onto take-up spool. Check to insure that the film is engaged with the sprocket.

h. Place cover into place making sure the cutout holes are in their correct positions. Secure with the corner screws and tighten. Final tightening may be done in daylight.

3. Cassette Installation

a. Open the film recorder access door by loosening the quarter-turn fasteners which hold it in place.

b. Note the position of the drive spline and rotate the cassette spline handle to hold the spline in the disengaged position.

c. Insert the cassette into place on the stabilized platform. This step is accomplished more readily if the stabilization system is off and the platform is free to move.

d. Engage the right side and middle cassette fastener thumb screws and turn until just snug.

e. Remove the metal spline spacer from the spline knob and engage the spline into its socket. Tighten the three-hold-down thumb screws.

f. Close the film magazine access door and secure with its fasteners.

C. PREPARE DETECTOR/DEWAR ASSEMBLY

1. Detector/Dewar Assembly Removal

a. Remove detector hold-down ring by pushing the two push-button release snaps.

WARNING: ALWAYS CHECK FOR MOISTURE (May be dried out with heat gun. See Appendix H)

b. Carefully remove two orange cables to preamp by rotating the outer collar counter clockwise.

c. Lift detector/dewar assembly carefully out of scanner.

2. Filter Change

a. The filter can be changed without removing the orange preamp cables, being careful not to pull on cables.

b. Remove the undesired filter (or metal shield) by rotating counterclockwise (CCW). Daylight operation may be with a 4.5 - 5.5 micron filter.

c. Replace the desired filter by reversing step b.

3. Detector/Dewar Assembly Installation

a. Carefully connect orange cables to preamp, matching cable number with chassis-connector number. Rotate connector collars clockwise (CW) until the connector is secure. Low frequency noise will appear on the A-Scan video if the connectors are not tight.

b. Carefully place the detector/dewar assembly into the scanner, aligning the detector with the hole in the scanner. The knob on the dewar should be toward the left rear of the scanner.

c. Carefully place detector hold-down ring in position. The bundle of wires should be above ring.

d. Push hold-down ring push-button snaps to secure detector in position.

D. FINAL CHECK OF CONNECTORS

1. Make sure all cables are secured, following CABLE INTERCONNECTION DIAGRAM (Exhibit B-3)

   a. The multi-conductor silver-colored connectors are push-on-type - NO TWIST.

   b. The olive-drab connectors push in and then lock with threaded lock ring.

E. CONTROL UNIT SETUP

1. Turn POWER switch to OFF.

2. Turn glow tube INTENSITY control to -5 (full CCW).

3. Turn V/H (knots/1,000 ft.) control to 0 (CCW).

4. Turn VOLTAGE CLIPPING control to 0 (full CW).

5. Turn COARSE ATTENUATION switch to 40.

6. Turn FINE ATTENUATION control to 10 (CW).

F. PRINTER SCOPE SETUP (CONTROLS BELOW CAMERA)

1. Turn INTENSITY control to 0 (CCW).

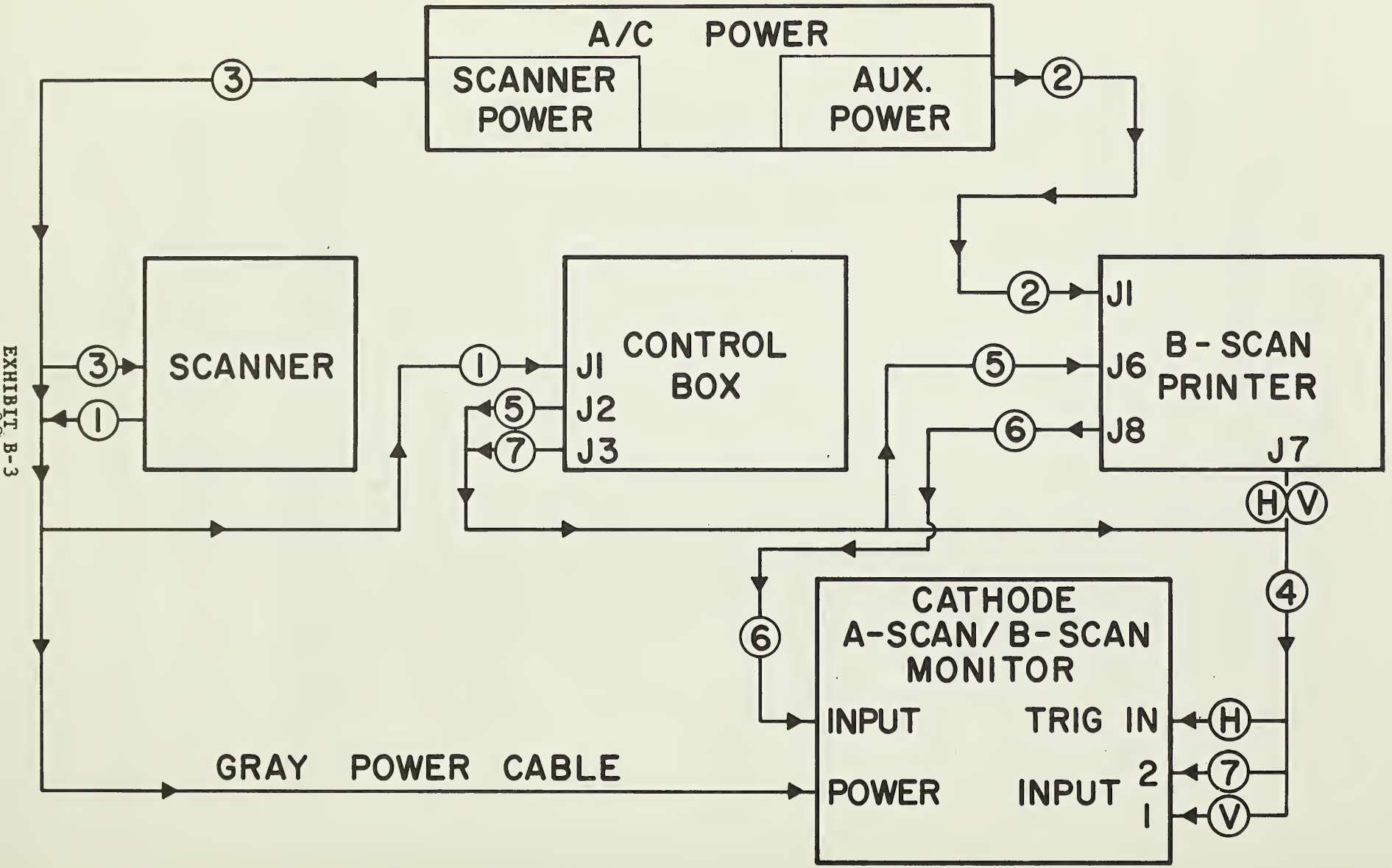
2. Turn CONTRAST control to 40.

3. Turn FOCUS to Maximum (CW).

4. Set OFF-ON switch to OFF.

5. Set FIELD-OF-VIEW (FOV) switch as desired (120^{o} - 60^{o} Scan Angle Switch).

CABLE INTERCONNECTION DIAGRAM FOR FIRE-MAPPING SYSTEM



G. DUAL POLAROID CAMERA PREPARATION

1. Open slate door below camera by releasing the one-quarter turn knob.

   a. Wind clock.

   b. Set clock

   c. Write date and location of missions with black lead pencil on slate area between clock and counter.

   d. Close slate door and rotate locking knob to the lock position.

2. Close shutter by actuating SHUTTER RELEASE LEVER on lens, insuring that it is in LOWER POSITION (closed).

3. Set f/stop as desired.

   a. f/5.6 is used most frequently. Intensity control is increased two divisions on the dial when switching to 60^{o} scan angle -- decreased the same amount when returned to 120^{o} scan angle.

   b. f/4 works well for 60^{o} imagery; f/8 works well for 120^{o} imagery.

   c. Other values of f/number may be used if intensities on printer are changed accordingly.

4. Set shutter timing mechanism on T (Time).

H. MONITOR SCOPE SETUP

1. Push POWER switch to OFF (IN)

2. Set TIME/DIV control to EXT HORIZ (CCW).

3. Pull TIME/DIV 10 MAG control.

   Note: TRIGGERING controls have no effect, and TIME/DIV VARIABLE has no effect.

4. Turn SCALE ILLUM to OFF (CCW).

5. Channel Switch Setups

a. Set CHANNEL 1, VOLTS/DIV control to 1.

b. Set CHANNEL 1, AC-GND-DC control to DC.

c. Set CHANNEL SELECTOR SWITCH control to CH 2.

d. Set CHANNEL 2, VOLTS/DIV control to 2.

e. Set CHANNEL 2, VOLTS/DIV variable to CAL (CW).

f. Push CHANNEL 2, INVERT control IN.

g. Push CHANNEL 2, X10 GAIN control IN.

h. Set CHANNEL 2, AC-GND-DC control to DC.

THIS COMPLETES THE PREFLIGHT CONTROL SETTINGS FOR THE FIRE MAPPING SYSTEM

APPENDIX C

IN-FLIGHT OPERATIONS

The following in-flight operating instructions cover the steps required for mapping operations.

A. DETECTOR COLLANT

Fill detector with liquid nitrogen, using small funnel.
WARNING: Try to keep from coming in contact with liquid nitrogen, as it can cause skin burns.

B. TURN-ON-PROCEDURES

1. Master Power Switch On (Ask Pilot) (Note: Scanner power breaker and camera power breaker must both be ON.)

2. Monitor Scope Power

Pull POWER switch to ON, and Observe the light directly above the power switch for flow, indicating power ON.

3. Control Unit

Switch main POWER control to "MAN POWER", pause momentarily, then switch to Scanner Motor. Observe chain drive next to detector in main scanner until chain stops. This indicates scanner window is open.

4. Printer Scope and Camera Power

Switch Printer OFF-ON control to ON.

5. Return to control unit and run a leader on the 70 mm film to place unexposed film over the recording head. This step is necessary only if the 70 mm film magazine has been exposed to light.

a. Set V/H control to fully clockwise position (CW).

b. Switch main POWER control to FILM DRIVE for at least one minute.

c. Switch MAIN POWER control to SCANNER MOTOR after one minute.

d. Return V/H control to 0 (CCW).

e. A 2 to 3-foot leader has now been run on the 70 mm film.

C. STEP PROCEDURE FOR MONITOR SCOPE OPERATION CHANNEL 1

1. Monitor Scope Adjustments (See Chart 1)

Switch channel selector to CH 1. There should be a trace moving slowly upward across the face of the CRT. If trace is visible, proceed with "2" and "3" below; if not:

a. Increase V/H (Control box) setting to about 100.

b. Increase INTENSITY.

c. Adjust CHANNEL 1 vertical POSITION to position trace on bottom line.

d. Push sweep RESET control (on front of camera) while further adjusting CHANNEL 1 vertical POSITION until trace starts on bottom line.

e. Adjust variable volts division control until trace just reaches top line before resetting to bottom.

2. Checking Operational Levels

a. Check system operation by switching channel selector to CH 2. If a trace is visible on Channel 2, return to Channel 1 and proceed with "3"; if not, follow procedure for Channel 2 setup in Section D, below.

b. If a trace is visible on Channel 2 and still not on Channel 1, increase V/H to Maximum and simultaneously adjust Channel 1 vertical POSITION and CHANNEL 1, VARIABLE, VOLTS/DIV controls.

V/H CHART
FOR 110 KNOTS

FORMULA: Elevation over terrain divided into speed.
3/ 110 = 36.6

CONTROL BOX V/H DIAL SETTING NO.	ELEVATION IN M OVER TERRAIN	120° COVERAGE IN FEET	APPROXIMATE MILES
110	1	3,460	½ +
55	2	6,920	1 +
36.6	3	10,380	2 -
27.5	4	13,840	2½ +
22	5	17,300	3 +
18.3	6	20,760	4 -
15.7	7	24,220	4½ +
13.7	8	27,680	5 +
12.2	9	31,140	6 -
11	10	34,600	6½ +

CHART 1

3. Intensity Checks

a. Adjust INTENSITY for a fine dim trace. Hot and cold terrain should begin to show as light and dark spots, respectively.

b. Place VIEWING HOOD on monitor and allow eyes to become dark adapted (Optional).

c. Adjust INTENSITY control (also FOCUS and ASTIGMATISM control is necessary) until a map-like presentation appears on the scope face. The intensity will normally be quite low (Optional).

D. SETUP PROCEDURE FOR MONITORING CHANNEL 2 AND 70 MM EXPOSURE OPERATIONS

1. Set up the MONITOR SCOPE for Channel 2 Operation as follows:

a. Adjust INTENSITY for a good trace. If no trace appears, adjust the CHANNEL 2 vertical POSITION control and the horizontal POSITION control until trace is located.

Simultaneously adjust. Horizontal POSITION to approximately center the trace, and HORIZ ATTEN to approximately 10 divisions.

b. Re-adjust INTENSITY for a desired trace.

c. Adjust FOCUS control and ASTIGMATISM control for a fine line across the CRT.

d. Disconnect INPUT 2 coax and using CHANNEL 2 vertical POSITION, set trace one division above bottom line.

e. Reconnect INPUT 2 coax.

2. Control Box Adjustments for 70 mm Operation, on Monitor Scope, Channel 2.

   a. Using glow tube INTENSITY (GTI) control (control box), position the trace up another 1 1/2 squares (3 volts or a total of 2 1/2 squares from bottom line on monitor scope).

   b. Using COARSE AND FINE SIGNAL ATTENUATION control (control box) adjust the peak-to-peak a. c. background signal to about 2 1/2 quares (5 volts). For extremely hot fires, adjust to about 1 volt peak, to avoid overdrive.

   c. Adjust V/H (knots/1,000 ft.) control for desired setting. Check with pilot for ground speed and average elevation. To determine the desired V/H number, divide the estimated ground speed by average number of feet above terrain, e.g.,

$$V/H = \frac{110}{2} \quad \frac{\text{Knots}}{\text{1,000 ft. altitude}} = 55 \text{ dial setting}$$

   CAUTION: Whenever information is not to be gathered for some period of time return GTI to -5 and V/H to 0. This will extend glow tube life.

   Note: The 70 mm printer is now properly adjusted, monitored, and ready to print. When a pass is to be made, the control box POWER switch is turned to FILM DRIVE, only while film is to be printed. The above settings are nominal operational level's for the system.

E. PRINTER SCOPE AND DUAL POLAROID CAMERA OPERATIONAL PROCEDURE

1. Loading Film Packs

   a. Make sure there is no film in camera; if there is DO NOT OPEN. Use, and refer below to reload film during flight.

   b. Carefully open two (2) Polaroid film packs (type 107, speed 3000) following directions on the sealed envelope.

   c. Open camera backs by carefully pushing release levers on the top and bottom of the camera.

d. Check film rollers in camera back. To release rollers, lift red lock. Clean rollers with soft cotton or cloth.

e. Close and lock film rollers. Press until lock clicks.

f. Remove old film pack from camera and insert a new film pack into camera, handling as directed on film pack.

g. Carefully place film pulling tabs and the black dark-slide tab in position for pulling after camera is closed.

h. Carefully close camera. The camera backs may have to be lifted slightly to insure proper closing. Check camera backs to see that they are locked on both top and bottom.

2. Checking Polaroid Camera Operation

a. When printer power was applied, the dual-flipping mirror began to operate. Check operation by pressing RESET button on front of camera. The mirror should flip and the ON amber light should switch sides.

b. Check shutter operation by pressing SHUTTER RELEASE mechanism on right side of viewing hood. The green light on camera front should be ON when the shutter is open.

c. Close shutter by pressing SHUTTER RELEASE.

3. Preparing Film for Exposure

Pull film pack dark slides (black paper in Polaroid pack). The dual Polaroid camera is now ready to take pictures when the shutter is opened. Adjust printer before opening shutter.

4. Setup Variations

a. Initial setup for a V/H of about 50 and 120° Scan Angle.

(1) Open viewing window on camera viewing hood.

(2) Adjust INTENSITY to view a dim trace line.

(An intensity modulated blue line should be visible. The blue line will appear similar to amber line on monitor.)

(3) Visually check the slate lighting on right side of CRT image for soft glow.

(4) Close viewing hood window.

(5) Set f/stop on the lens to f/5.6.

(6) Set Scan Angle Switch (FOV) Field-of-View control to 120.

(7) Read sections b, c, and d, below, then proceed to test overall operation. (Section 5)

b. Setup for a V/H - 50 and 60° Scan Angle.

(1) Set up for 120° Scan Angle as in Section a. above.

(2) Change Scan Angle Switch control to 60.

(3) Reduce f/stop by two (2) f/numbers; e.g., from f/8 through f/5.6 to f/4, or increase intensity control by two (2) divisions on intensity control dial.

c. Setup Procedure for a V/H other than 50.

(1) For an increase in V/H above 50, increase INTENSITY on printer.

Note: The amount of increase in intensity will depend upon the change in V/H. The correct value will have to be found experimentally. The INTENSITY control is sensitive.

(2) For a decrease in V/H below 50, reduce the intensity on the printer.

d. Variations in f/Number.

As previously implied, the printer intensity and the camera f/stop can be adjusted within limits to give the same change on the film.

(1) A decrease in intensity has the same effect on the film as an increase in f/number and vice-versa.

(2) For any change in V/H, the film density must be compensated by a corresponding change in f/number or printer INTENSITY, a difference of two divisions on the Intensity Control Dial.

Note: The printer scope and monitor intensities are not controlled by the V/H control. Intensity for the 70mm printer is controlled by the Glow Tube Intensity Control on control box.

5. Testing Overall Operation

a. The shutter can now be opened to run a test frame; then close shutter. Pull film carefully.

(1) If picture is too white, slightly reduce the printer INTENSITY.

(2) If picture is too black, slightly increase the printer INTENSITY.

b. Re-run test frame

(1) Repeat re-runs as necessary. At this point, experience is the only teacher.

(2) Contrast on the printer scope is controlled by the SIGNAL ATTENUATION controls (control box.) The CONTRAST control on the printer is used only to present the printer contrast. Slight adjustments of the printer CONTRAST control may be necessary occasionally to improve the quality of the imagery. Usually the contrast should be reduced to improve the imagery.

(3) Direction of flight changes require changes in intensity control. To East may require up to 1.5 divisions more than when flights are made to West. Due North and South flights use the same settings. Other flight direction variations require changes up to 1.0 divisions.

6. Over Fire Operations

a. Check with pilot for aircraft alignment with desired area for first pass over fire.

b. Open shutter by pressing SHUTTER RELEASE.

c. Carefully remove exposed film immediately after mirror has flipped to other side. Repeat until pass over desired area is complete, then CLOSE SHUTTER at end of frame.

d. Repeat Items a. through c. for each pass, being sure to pull the correct picture and to close shutter at end of each pass.

7. To Reload Film During Flight

a. If both film packs are not to be loaded at the same time, the first frame of film pack remaining in camera will be exposed and should be removed after camera is closed. If aircraft is totally dark, no loss of film will occur.

b. Proceed to open camera and reload as described in Section E-1 above.

c. Film SHOULD NOT be reloaded while making imagery.

F. SCANNER SHUT DOWN

1. Follow this procedure when necessary to terminate scanner operations.

a. Close camera shutter.

b. Turn glow tube INTENSITY to -5 (CCW).

c. Turn V/H (knots/1,000 ft.) to 0 (CCW).

d. Turn printer scope INTENSITY to 0 (CCW).

e. Switch printer scope OFF-ON switch to OFF.

f. Turn control box POWER control to OFF (CCW).

g. Push monitor scope POWER switch OFF (in).

2. Advise pilot equipment is off.

APPENDIX D

IMAGERY DELIVERY BY AIR DROP

The following procedure outlines the steps that are followed after imagery is completed. A drop may be made, depending upon advance arrangements.

A. PREPARATION OF IMAGERY

1. Scanner equipment MUST be turned off.

2. Imagery should be coated with preservative and allowed to dry.

3. Place imagery in envelope; using large size envelope for daytime drops with high visibility tube. Small envelopes are used for night drops, in clear tubes so light can be easily seen.

4. Mark envelope with the following information:

   a. Mission and sortie number (Example: 8-1)

   b. Name of fire and Forest

   c. Date

   d. Time

B. PREPARING EJECTOR ASSEMBLY

1. WITH PILOT'S PERMISSION, open hydraulic door.

2. Place ejector tube in proper position.

3. Remove electro-magnetic retaining chamber.

4. Place envelope of imagery in plastic drop capsule.

5. Insert metal end on plastic capsule into electro-magnet hole Wait for pilot's order to connect electrical wires on horn (or light if at night).

C. DROPPING PROCEDURE (FOR OPERATOR)

1. At pilot's command insert, drop capsule into ejector tube. Pilot will then complete drop pass, and trigger the drop.

2. After drop is made, remove ejector tube and WITH PILOT'S PERMISSION close hydraulic door.

APPENDIX E

P-2 AERIAL CAMERA OPERATION

The present aircraft also is capable of taking regular aerial photographs with a military surplus 70 mm aerial camera. This camera uses the same port, with hydraulic door, that is used for the ejector tube assembly in dropping imagery.

A. INSTALLING CAMERA

Note: Camera should be loaded with film previous to mission departure.

1. Camera Controls. These settings are for normal use with Kodak plus X film.

   a. F/stop - 500

   b. Haze - B

   c. Camera Control Box - Haze

2. Camera Placement and Power

   a. Connect camera power outlet, screw on type, to camera control box.

   b. Open hydraulic door.

   c. Place camera in hole with arrow in direction of travel.

   d. Connect camera control box power outlet to aircraft power outlet, snap together type.

3. Controls

   a. Push button control is located on right side of equipment stand.

   b. To clear film push button four (4) times.

   c. 80^{o} photos are obtained. At 110 knots and 2000' over terrain, approximately 20 seconds between pictures will obtain a 1/8 overlap.

B. REMOVAL AFTER USE

Reverse procedure for removing camera.

APPENDIX F

AIRCRAFT OPERATING TECHNIQUES FOR INFRARED MAPPING

This list constitutes a partial reminder list for the pilot during infrared fire mapping operations.

1. If possible obtain coordinates, V.O.R. radials and cross bearings of fire location.

2. Maintain radio contact with air traffic control. They may be helpful in positioning your aircraft over the fire area.

3. Obtain the elevation and approximate size of the fire. This will help predetermine the approximate altitude required.

4. Imagery run headings must be determined upon arrival over the fire. Runs should be made either up or down wind; never cross wind.

5. Inform equipment operator when to begin imagery run and give him heading on each pass.

6. Aircraft heading, altitude and 110 knot ground speed must be held constant during each pass.

7. Pilot must maintain radio contact with the air attack boss during each sortie, or with the air traffic controller over the fire.

8. After imagery is obtained and a drop is required, clearance must be obtained from the air attack boss and contact should be made with the coordinator-interpreter.

9. The pilot will inspect and approve all drop areas before making a drop.

10. Inform equipment operator to prepare for imagery drop. He will open hydraulic door, install ejector tube and insert plastic drop capsule, at pilot's command.

11. Inform equipment operator when to secure all dropping equipment.

12. If the P-2 aerial camera is used, pilot's permission for installation should be given at proper time.

13. No imagery drops will be made at night unless the pilot has made at least one daylight drop in the area.

14. Upon returning to base of operations prepare aircraft for next sortie.

APPENDIX G

MISSION AND SORTIE CHECKLISTS

These lists comprise the materials and supplies essential to the successful completion of missions and sorties. Omission of any item may result in failure to accomplish objectives.

FIRE MAPPING CHECK LIST FOR MISSION

NO.	ITEM	WEIGHT
1	25 Liter Dewar-FULL	62#
2	Film-a. Polaroid packets (3 1/4x4 1/4-3000-107 3/4 # each) 24 each	18#
	b. 70mm Scanner (100' rolls Kodak Tri-X Pan TX475 1 1/2 # each) 5 rls.	8#
	c. 70mm P-2 (100' roll Kodak plus X Aerecon SP484 1 1/2 # each) 2 rls.	3#
3	Dropping Tube Assembly	4#
	Drop Capsules a. Day-16 each 1 lb.	16#
	b. Night-10 each 1 lb.	10#
	P-2 Camera and Camera Control	14#
4	Thermos Bottle for Nitrogen	5#
5	Radios, each 1, for ground Coordinator	12#
6	Flashlite w/extra batteries	1#
7	Regional Maps	20#
8	Copy Camera	9#
9	Envelopes (2 sizes - Brown Manila)	1#
10	File Folders (3 each) in with Regional Maps	
11	Forms & Clip Board a. Scanner data b. Flight Operations c. Dispatcher	2#
12	Tools & accessories in Canvas holder on pegboard	14#
13	Filter 4.5-5.5	
14	Interpreter Kit, Brief Case	18#
15	Photo developer tanks w/D19 developer (4 gals), Rapid fix, Photo flo, thermometer, scissors, masking tape, stirring sticks.	56#

16	I.R. EQUIPMENT	
	a. Scanner	90#
	b. Control Box	20#
	c. Printer Scope with Polaroid camera attachment	43#
	d. Monitor Scope	20#
	e. All necessary connecting cables (9 total incl. 2 on back of Printer Scope)	6#
17	Personal gear	50#
18	Tools & Spare Parts (Include heat gun for drying detector. This gun built for use with shrinkable tubing. It is to be used to thaw out and dry detector after freezing.)	30#

FIRE MAPPING CHECK LIST FOR SORTIE

NO.	ITEM	WEIGHT
1	Thermos FULL Nitrogen	5#
2	Film-Polaroid packets 6 each, or as needed for mission	4 1/2#
3	Dropping tube & capsules, day or night 4 each, 1 lb each	4#
4	Radio	12#
5	Local Maps	2#
6	Envelopes & file folder	1#
7	Filter 4.5-5.5	
8	Waste Basket	4#
9	Copy Camera at night	9#
10	Forms: a. Scanner data b. In file folder (1) Flight Operation (2) Dispatcher	1#
11	V/H chart (Should be left in aircraft on left wall by equipment)	
12	I.R. Equipment	
	a. Scanner	90#
	b. Control	20#
	c. Printer Scope with Polaroid camera attachment	43#
	d. Monitor Scope	20#
	e. All necessary connecting cables (9 total including 2 on back of Printer Scope)	6#

REMOVE AIRCRAFT SCANNER HOLE COVER

APPENDIX H

HAND TOOL LIST

The following tools comprise an adequate emergency repair kit. They should be carried on missions and on sorties to allow the electronics-technician opportunity to make minor repairs.

1 - canvas tool bag (6" high by 6" wide by 10" long)

1 - pliers (diagonal cutting)

1 - pliers (needle nose)

1 - tool (dental exploring)

3 - clamping tools (X celite No. 42-R)

1 - screwdriver set (Xcelite No. PS-120)

1 - screwdriver set (X celite No. PS-88)

1 - wire stripper

2 - pliers (7" channel lock)

1 - screwdriver (6" standard blade)

1 - screwdriver (6" Phillips blade)

2 - wrenches (6" crescent)

1 - set, socket-drive (1/4")

1 - flashlight

1 - penlight

1 - Volt-Ohm Meter (Triplett Model 310c, with leader case)

1 - gun, soldering (Wen, Model 199 or equal)

1 - 1 lb roll multi-core solder (5 core) for transistor circuits

1 - case, catalog (leather) for manuals and spare parts

1 - gun, heat (Built for use with shrinkable tubing -- to be used to dry out detector after freezing)

APPENDIX I

POSITION DESCRIPTIONS

Sample position descriptions have been included in this appendix. They are intended to serve as a guide. Positions and format may vary from one agency to the next, as situations dictate and as the unit is used.

COORDINATOR - INTERPRETER

(Infrared Fire Mapping)

I. INTRODUCTION: Serves as project leader in charge of the Infrared Fire Mapping Unit which produces photo-like imagery of forest fire areas and surrounding terrain for use in planning fire fighting strategy. This unit is mounted on a light twin-engine aircraft, and used both at night and in the daytime. Information obtained fills scouting or reconnaissance needs relating to location, size, and identification of fire areas and other physical features. May be assigned anywhere in the United States.

The Unit consists of the crew, the aircraft and the special equipment. The crew includes this coordinator-interpreter, the pilot, and the electronics technician operator. It may also include a part-time electronics technician. The Aero-Commander plane is modified to accept the airborne equipment. The equipment consists of a rotating optics system which scans a given arc under the aircraft, normal to the line of flight, and focuses the radiated thermal energy on an infrared detector. The electrical signal output of the detector is amplified and used to control the intensity of a glow tube which scans a moving film in sychronism with the original optics system. The result is imagery having characteristics of a photograph but produced one line at a time and having shade from black to white proportional to the temperature of source objects.

Mapping action on a fire is initiated by request to the Region 4 dispatcher who relays all available information to the mapping crews. The first sortie is generally made before landing at the local airport nearest the fire, after which the ground coordinator takes the imagery to the fire camp or designated headquarters and interprets it for the planning officer. Succeeding sorties are made from this airport and vary in procedure only to the extent that imagery is dropped directly to the planning headquarters. Activity is coordinated by radiophone.

II. PRINCIPAL DUTIES AND RESPONSIBILITIES

As project leader the incumbent is responsible for planning, direction and coordination of the unit as it may be assigned nationwide. He shares with his superior responsibilities for meeting Forest Service goals. The nature of the project demands coordination across division lines of technology in electronics; with all Forest Service regions, with research for updating the equipment development; with other agencies, states, fire services, and OCD to meet operational objectives.

A. Staff responsibilities

1. Policy, Programs and Plans

Within the stated policy on use of the infrared mapping unit, the incumbent actively plans and executes the program of work. Progress reports are submitted weekly for administrative use. Plans contain target dates for completion of tasks and name of project member assigned.

2. Direction

Has full authority to make commitments for the unit and decisions concerning its activities when on a mission. Is responsible for technical directions including the administration of contracts by suppliers.

3. Coordination

Coordinates activities of the pilot, equipment operator, and electronic technician. When on a mission coordinates operation of the unit with the Region, the Forest, and the project fire overhead as effected by the mission. The same applies to other agencies and fire services.

B. Specific Project Responsibilities

1. Manages logistics, and is responsible for all phases of the work going forward. This includes planning, scheduling and implementing of the approved program of work.

2. Analyzes and reports on findings for improvement of procedures and of imagery. Elements include: direction of flight, height over terrain, time of day, flight bearing or direction, capsule dropping methods, and imagery interpretation. Recommends changes.

3. Explains the scope, objectives, and progress of the work to fire staff and others, singly and in groups, in all agencies and fire services served.

4. Is responsible for the Unit maintaining a state of readiness for prompt assignment.

5. On fire mapping missions, supervises and directs the operation in line with the responsibilities that are assigned to the pilot and to the equipment operator. Also performs the following tasks.

a. In the absence of the equipment operator, may operate the infrared scanner and camera equipment to obtain imagery. This may include installation of the infrared scanner, the control box, B-scan printer, and A-scan/B-scan monitor, the dual polaroid camera, the 70 millimeter camera cassette. It includes alignment, adjustment and testing of these various equipments. It includes inflight operation of these equipments, and the loading and removing of film, printing and enlargement of imagery and the operation of the drop capsule launcher.

b. Obtains and analyzes all available information on the fire situation; determines time of day, frequency of sorties, direction of flights, height over terrain, and portion of fire perimeter to map first. Together with the pilot, selects drop area and assesses hazards.

c. By applying photogrametric techniques to the imagery obtained, develops enlarged photograph of the original imagery. Prepares fire maps and assists the fire plans staff in interpreting and using this information.

d. Observes conditions of the fire, applies knowledge of fuels, terrain, weather, and fire behavior to determine suitability of procedures and equipment for obtaining fire intelligence.

e. Performs or provides on-the-job training to imagery interpreters on fires; to transcribe fire perimeters, spot fires and other intelligence information from infrared imagery to aerial photos and/or to maps for use in fire management.

f. Performs or provides training in photogrametric techniques to develop enlarged photographs of the original polaroid imagery (3 1/4" by 4 1/4" to 10" by 12" size) and develops 70 millimeter strip film for use and for permanent record.

g. Trains the electronic technician and other personnel as assigned in some operations of the scanner equipment.

h. Relieves the electronics technician in the aircraft on scanner operation, mechanical maintenance, and other duties when mission frequency causes operator fatigue.

i. Upon notification by the Regional Fire Coordinator to obtain imagery for other agencies, establishes and maintains liaison with the using agency.

j. Prepares written narrative reports of each mission with sample imagery showing results obtained. Information is provided to all agencies involved.

k. Serves as principal advisor to Forest Service personnel on operational procedure for the infrared unit in the mapping and measurement of fires.

l. Supervises the development and maintains a complete file of all information obtained on each mission for reference analysis and future use.

m. Provides financial plan, work plan and work schedules.

n. Selects and arranges preparation of 35 millimeter slides best suited for presentation by himself and other staff at fire service meetings.

6. Trains others. A major objective of the project is to build a cadre of trained personnel to operate the infrared mapping unit and to use its output. Both on-the-fire training and formal classroom instruction is given. The incumbent plans and conducts a comprehensive training program on the use of infrared equipment and techniques in the mapping of both rural and urban fires. Training tasks:

a. Develops subject matter outlines and lesson plans.

b. Plans and conducts training schools in the use of infrared principles, techniques and equipment. Besides Forest Service, trainees come from other agencies, from states and other fire services.

c. Serves as instructor in the operational techniques for infrared fire mapping.

d. Serves as principal instructor in imagery interpretation.

e. The incumbent provides guidance to other unit members in the preparation of lesson plans for training the technical phases of the work.

III. CONTROLS OVER THE POSITION

General supervision is exercised by the Northern Zone Air Operations officer. Liaison with OCD and guidance is provided by the Washington Office, Division of Fire Control. The incumbent acts independently to manage the operational logistics and to accomplish the objectives. He collaborates with and receives counsel from others in air operations, in fire control, in electronics and in administrative services.

Reports will usually be prepared in draft, then reviewed by the whole team seeking the best technical solutions. Incumbent is completely responsible for soundness of data in completed reports which are not subject to further review.

Agency directives and policy statements are available as guides.

IV. OTHER SIGNIFICANT REQUIREMENTS

Contacts with fire leaders and personnel from other Forest Service Regions, other agencies, fire services and OCD require tact, sincerity, broad understanding and ability to develop sound working relationships. Extensive working knowledge of Forest Service operating rules and practices is desirable. Ability to write clear, concise reports is necessary. Initiative and ability to understand related research and fire control and rural and urban and wildland fire situations is required. Other demands include: mental energy to meet demanding deadlines, ability to organize and manage logistics, analytical abilities, capacity for long and irregular

hours of work under emergency firefighting conditions. Incumbent must have wide experience and knowledge in fire control and in Forest Service administration. He must have working knowledge of procedures used by all other fire services.

In developing, testing, and evaluating the infrared fire mapping concept, equipment, and procedures, the results can become a significant component of the nationwide fire intelligence system. The scope of the work performed by the incumbent directly influences the capabilities of forest fire organizations to combat fire efficiently and safely. Leadership, sound judgment, and competence in executing the missions, determines the productivity of this new intelligence gathering technique. The quality of the work will have much influence on the acceptance of the output by the fire services.

SAMPLE
Position Description

ELECTRONICS-TECHNICIAN-OPERATOR
(Infrared Fire Mapping)

I. INTRODUCTION: Serves as Electronics technician with the Infrared Fire Mapping Unit which produces photo-like imagery of forest fire areas and surrounding terrain for use in planning fire fighting strategy. The information includes location of the fire perimeter with respect to surrounding terrain, location and relative size of spot fires outside the fire perimeter, and identification of natural and man-made features such as roads, streams, lakes, trails, buildings, bridges, dams, etc. The IR mapping system is mounted in a light twin-engine aircraft and used at night as well as daytime.

The incumbent must possess above average skill as an electronic technician and have a knowledge of optics and photography. He must be capable of photo-processing with a knowledge of both developing and printing. His electronics knowledge and skill must include ability to adjust and repair high-gain video circuits, high voltage circuits associated with cathode ray tubes, gating circuits, dc restoring circuits, clipping circuits, and saw-tooth circuits associated with cathode ray tube raster scans. Optics knowledge must include care and maintenance of mirrors and reflecting surfaces used to focus infrared energy on the IR detector. Photography skill must include ability to operate a dual Polaroid flipping mirror B-scan camera and a P-2 aerial camera including all adjustments to produce sharp images. Incumbent must be capable of developing and printing film for photo-interpretation and permanent record purposes.

II. PRINCIPAL DUTIES AND RESPONSIBILITIES: Incumbent (1) installs, maintains, and repairs an airborne infrared thermal imaging system; (2) operates such a system on fire and other assigned thermal mapping projects; (3) processes imagery from the thermal infrared imaging system for use by fire management; (4) operates other camera equipment associated with the infrared mapping system; (5) processes film from cameras and imaging devices; (6) prepares periodic technical reports covering operation and performance of the infrared imaging system, with recommendations for improvements; (7) maintains in good order test instruments and supplies necessary for routine maintenance of the IR imaging system and associated electronic equipment; (8) maintains a fresh stock of photo supplies necessary for normal operation of the IR mapping unit; and (9) makes modifications to electronic equipment only as specifically directed by a professional engineering supervisor.

III. CONTROLS OVER THE POSITION: Incumbent will be under the administrative supervision of the Infrared Coordination Officer but receive technical guidance and direction from a professional electronics engineer in accordance with establishing policy for technical supervision of electronics technicians.

IV. OTHER SIGNIFICANT REQUIREMENTS: The incumbent must be physically able and willing to fly in aircraft on assignments involving hazards normal to operations on going fires. Incumbent may be required to fly at night.

SAMPLE
Position Description

AIRCRAFT PILOT
(Infrared Fire Mapping)

I. INTRODUCTION: Under the general supervision of the Chief Pilot, individually operates a variety of assigned aircraft for the discovery, mapping and suppression of wildland fires for aerial reconnaissance, aerial photography, reseeding, spraying, dusting, dropping cargo and jumpers, and transport of personnel and freight. May be assigned anywhere in the United States.

Broad as well as intimate knowledge of operational requirements, facilities, practices and procedures relating to service activities is required.

In addition, receives special training and applies skill, knowledge and judgment as pilot for the Infrared Fire Mapping Unit.

II. PRINCIPAL DUTIES AND RESPONSIBILITIES: Operates assigned aircraft of 205 h. p. to 2, 550 h. p. with carrying capacity of 4 to 25 persons; including the use of instruments in adverse weather, for night flying, over uncharted courses where ground navigation aids are absent. Applies judgment within approved policy in the use of meadows, roads or other marginal landing areas. Considers elevation, terrain, obstructions, length of runways, weather, time of day and aircraft performance.

On large projects and fires, which occur annually in the western half of the United States, assumes the role as Chief of Air Operations and as

such inspects contract aircraft for airworthiness, capacity for passengers and cargo, and other limitations for safe use. Determines areas that may be used for landing, best uses that can be made of available craft, the number and kind of craft needed. Interrogates available pilots concerning their experience, and for those selected, provides special instructions concerning safety precautions, methods, controls and accuracy required for dropping smokejumpers, cargo and chemicals, and other missions.

Makes pre-season flights to train and instruct smokejumpers in safe methods and for the accuracy required in parachuting with equipment in inaccessible and rough terrain. Participates in pre-season schools to train and instruct associated ground personnel including dispatchers, observers, cargo packers and droppers and other overhead personnel in safe methods and limitations on the use of aircraft in fire suppression and wildland management.

During the non-fire seasons, or periods between fires, transports Regional personnel between headquarters areas, or for making aerial reconnaissance or surveys for such land management tasks as proposed road locations, game counts, location and extent of timber and forage range and watershed surveys. Makes special flights for testing experimental work on aerial photogrammetry and in taking pictures, requiring precision flying as to speed, direction and altitude with a minimum of deviations. Makes special flights including range or tree reseeding, revegetation for

flood control, for dusting, baiting, or spraying for control of insects, brush or disease, requiring extremely low flight over rugged and inaccessible terrain.

Makes preflight check of flying and weather conditions at point of departure, at points along route and at destinations; services equipment with gas and oil, makes minor operating adjustments; maintains accurate logs of flight including work as assigned.

As Infrared Fire Mapping Pilot, the incumbent receives special training and performs special tasks anywhere in the UnitedStates as follows:

Serves as pilot in command of aircraft equipped with infrared scanner, performing both day and night over rugged terrain, over wild fires and prescribed fires, requiring precise navigation without many of the usual aids, under adverse conditions of low visibility and extra hazardous low level flying.

Operates aircraft in a precise manner, maintaining exact air speed, bearing, altitude, attitude for minimum crab, roll or other variations; all under conditions of turbulence and smoke associated with large forest fires.

Coordinates flight with equipment operator to obtain best imagery of the fire.

Selects airport for use between sorties, considering lighting, instrument aids, runway length, etc.

Coordinates sorties with FAA and Air Traffic Control while mapping near controlled air space.

Analyzes fire locations and terrain conditions.

During a sortie: determines height over terrain and flight bearings for best imagery; maintains radio contact and coordinates with air attack boss at scene of fire; directs the equipment operator in preparing for imagery dropped, selects suitable drop zone, coordinates drop with ground personnel.

Performs maintenance on aircraft both in field and at base.

Instructs and trains other pilots in infrared fire mapping.

Maintains accurate records of all missions and sorties; prepares reports pertinent to the infrared mapping assignment.

Prepares drafts of operating procedures and specifications for aircraft modification, as required.

Participates in development and testing of devices and techniques to improve the mapping operation.

III. CONTROLS OVER THE POSITION: Assignment of plane and equipment as well as mission and purpose of trip is made by the Chief Pilot. Records and accomplishment are periodically reviewed by superior.

IV. OTHER SIGNIFICANT REQUIREMENTS: Mental demands include sound judgment, thorough knowledge of rules, regulations and theory of flight. Demonstrated ability is required: to fly or direct the flight of

aircraft through turbulent air and dense smoke resulting from major fires; to determine how and when craft may be used safely; to accurately spot safe places for the dropping of smokejumpers and cargo which requires taking into account wind velocities, direction, correct elevation action of fire; to make low flights over rugged topography in high elevation country for aerial reconnaissance, spraying, dusting, seeding, etc.; and to use instruments in take-off, landing, and directing the course of craft during periods of low visibility or on uncharted airways.

Personal work contacts outside the Service are made with officers and representatives of the Military Air Service, with owners and operators of chartered civilian planes to inspect equipment for use, for making arrangements for emergencies and in instructing other pilots concerning work assignments.

APPENDIX J

TRAINING GUIDELINES

This appendix contains detailed guidelines for the training of the primary infrared mapping crew, as well as interpreters who may be assigned on a detail basis.

A. COORDINATOR-INTERPRETER

A Coordinator-Interpreter must become a recognized expert in the field of interpretation of imagery. His training should be such that these skills are developed, together with the confidence necessary to lead in this field.

Ordinarily, the man in this position is the administrative officer responsible for the total operations of the unit. Training in administrative duties will necessarily be fitted to those of the fire control agency.

For the Coordinator-Interpreter portion of his duties, the following will apply.

1. Objectives

   a. Coordinator-Interpreters will be able to function efficiently as interpreters and instruct others in this field.

   b. Coordinator-Interpreters will have a thorough knowledge of the capabilities and limitations of all portions of the entire unit.

   c. Background knowledge will be adequate to allow Coordinator-Interpreters to present papers or discussions, and to prepare operational guides or manuals, as well as news media releases.

2. Pattern of Instruction

As noted above, it is most desirable that a new Coordinator-Interpreter be allowed to overlap for on-the-job training. In this way, a minimum of mistakes will be made by the new man. Actual fire experience is very effective and should be secured if at all possible.

B. INTERPRETERS

A two-day training course for the imagery interpreter includes instruction and practice in interpreting infrared imagery and transferring this intelligence to conventional aerial photographs and maps for use in tactical fire planning.

1. Objectives

a. Will be able to identify hot targets on infrared imagery.

b. Will be able to identify terrain and cultural features and gross vegetation types on infrared imagery.

c. Will be able to transcribe fire perimeters and spot fires from infrared imagery to aerial photographs and maps.

d. Will be able to measure linear rate of fire spread on infrared imagery.

2. Pattern of Instruction

The lecture portion on each subject should not involve more than 15 minutes per hour. The remaining time should be devoted to practical exercises. Upon completion of each subject, an examination should be given.

C. PILOT

The pilot should receive training and practice enabling him to fly precise courses both day and night over wildfires and prescribed fires occurring in rugged terrain.

1. Objectives

a. Will be capable of precision flying during a mapping pass, maintaining exact air speed, bearing, altitude, attitude for minimum crab, roll, or other variations.

b. Will be able to coordinate flight with equipment operator to obtain best imagery of the fire.

c. Will be able to coordinate sorties with FAA and Air Traffic Control during flights near controlled air space.

d. During a sortie pilot will be able to: determine height over terrain and flight bearings for best imagery; maintain radio contact and coordinate with airspace controller, usually the air attack boss at the scene of fire; direct the equipment operator in preparing for imagery drop, select suitable drop zone, and coordinate drop with ground personnel.

2. Pattern of Instruction

The most effective training is in-flight instruction and checkout by an experienced infrared fire mapping pilot. The trainee must learn the relationship between the flight path and the quality of the imagery.

D. ELECTRONICS TECHNICIAN-OPERATOR

The Electronics Technician-Operator receives training to familiarize him with the infrared fire mapping equipment, including scanner, polaroid cameras, auxillary devices and test equipment.

1. Objectives

   a. Will be able to develop and print film for photo-interpretation.

   b. Will be able to adjust and repair high-gain video circuits, high voltage circuits associated with cathode ray tubes, gating circuits, d.c. restoring circuits, clipping circuits, and saw-tooth circuits associated with cathode ray tube raster scans.

   c. Will be able to care for and maintain mirrors and reflecting surfaces that focus infrared energy on the infrared detector.

   d. Will be able to operate a dual Polaroid Flipping mirror printer scope camera and a P-2 aerial camera.

2. Pattern of Instruction

   The training method will be an on-the-job approach with additional self-study. This method may be easily adapted to a small group of five or less. The small number is necessary because of the need for constant use of the shop equipment in exercises.

APPENDIX K

FORMS AND MATERIALS LIST

This includes the principal forms used in the infrared mapping operation, together with a materials list for ejector assembly. These will be of value in setting up a mapping unit.

DISPATCHING LOG
PROJECT FIRE SCAN

No. _____
Date _____
Time _____

INITIAL CALL

1. Fire: _____

2. Location: _____

_____

T_____R_____S_____ Latitude_____Longitude_____

3. Agency and Subunits: _____

4. State: _____

5. Nearest Airport: _____

6. Followup Contact: _____ Phone No. _____

FIRST FOLLOWUP

7. Fire Description:

Control Status _____ Size _____

Est. Control _____ Character _____

Fuel Type _____ Topography _____

Weather _____ Elevation _____

Other (Mission agreeable, etc.) _____

_____

CREW ALERT

8. ETD: _____

9. Crew Notified: _____

10. Notification: _____ Reg. Disp. _____ For Disp.

11. ETA:_____ Airport_____Fire

12. I.I.I. Requirements:_____Photos_____Maps

_____Transportation

13. Special Instructions: _____

_____

FLIGHT OPERATION ORDER
PROJECT FIRE SCAN

No. _____
Date _____
Time _____

_____ Mission

1. Location: _____

_____

T____R____S____ Latitude_____Longitude_____

2. Agency and Subunits: _____

3. State: _____

4. Airport Destination: _____ETD_____ETA_____

5. Sortie Schedule:

No.	ETD	ETA	EOT	SCAN ANGLE
1				
2				
3				
4				
5				
6				

6. Target Elevation _____

7. Drop Zone Location _____

8. Crew Names: _____ _____ _____

_____ _____

9. Order Transmitted by _____Radio _____Phone _____Other

10. Special Instructions: _____

_____

AIRBORNE IR DATA COLLECTION SHEET 70 MM FILM

FLIGHT NO. DATE	PASS NO.												
TIME OFF TIME DOWN	TIME OVER TAR.												
PILOT	ALTITUDE												
OPERATOR	VELOCITY												
INTERPRETER	V/H SETTING												
TARGET LOCATION	GLOBE TUBE INTENSITY												
	SIGNAL ATTEN.												
AIRPORT	SIGNAL FINE												
OUTSIDE AIR TEMP.	VOLT CLIP												
ALOFT GROUND	HEADING °												
WEATHER CONDITIONS	POLAROID WAS MADE												
	A/C VOLTAGE												
	D/C VOLTAGE												
	P-2 PICTURES TAKEN												
	FILTER												
COMMENTS	REMARKS												
RECORDER													

EJECTOR ASSEMBLY MATERIALS LIST

	Item	Cost
1.	Electromagnet: type 518, model 2, 24 volts, Style A	$ 6.00
2.	Magnet cylinder attachment: 4 3/8 inches long, 3-inch diameter inside	1.00
3.	Two each aluminum plates: 1/16 inch thick	1.00
4.	Wooden block (optional size)	.25
5.	Two each bolts: 4-1/4 inches long, 5/8 inch diameter, @ 25¢	.50
6.	One each bolt and sleeve: 4-1/4 inches long, 3/8 inch diameter, 4-1/8 inch sleeve, 1/2 inch diameter outside	.45
7.	Aluminum cylinder: 24 inches by 3 inches outside diameter (metal thickness, 1/8 inch)	4.70
8.	One pair electrical snap connectors	2.90
9.	Aluminum angle floor brackets with screws, bolts and washers (optional size)	2.00
	TOTAL COST ESTIMATE	$18.90
	TOTAL WEIGHT LESS FLOOR BRACKETS	4-1/2 lbs.